Commonwealth of Massachusetts

State Hazard Mitigation Plan

October 2004

Prepared by:

The Massachusetts Emergency Management Agency (MEMA) and the Department of Conservation and Recreation (DCR)

MITT ROMNEY
Governor

KERRY M. HEALEY
Lt. Governor

CRISTINE MCCOMBS
Director, MEMA

KATHERINE F. ABBOTT
Commissioner, DCR

Table of Contents

Key Terms & Acronyms

All-hazards approach is an integrated hazard management strategy that incorporates planning for and consideration of all potential natural and man-made hazard threats

BBRS Massachusetts Board of Building Regulations and Standards

CDBG Community Development &Block Grant Program through the U.S. Department of Housing and Urban Development (HUD)

CFR Code of Federal Regulations

CMR Code of Massachusetts Regulations

CRS Community Rating System

CZM Massachusetts Coastal Zone Management

DCR Massachusetts Department of Conservation and Recreation (formerly DEM – Department of Environmental Management)

DEP Massachusetts Department of Environmental Protection

DHS Department of Homeland Security

DMA 2000 Disaster Mitigation Act of 2000

EOEA Massachusetts Executive Office of Environmental Affairs

EOPS Massachusetts Executive Office of Public Safety

EPA Environmental Protection Agency

FEMA Federal Emergency Management Agency

FMA Flood Mitigation Assistance Program

GAR Governor's Authorized Representative

HMGP Hazard Mitigation Grant Program

IFG Individual and Family Grant Program

MEMA Massachusetts Emergency Management Agency

MEMT Massachusetts Emergency Management Team

MEPA Massachusetts Environmental Policy Act

MHC Massachusetts Historical Commission

Mitigation is the process of reducing the severity of the impact of natural hazards through planning. Each hazard requires a specific type of mitigation. In some cases, we can use engineering solutions (such as an earthquake-resistant building) to at least temporarily reduce the impact of a natural hazard. In other cases, the only form of mitigation that is guaranteed to be successful is to limit or not allow human activities where the hazard occurs (such as in floodplains).

NFIP National Flood Insurance Program

Natural Hazard is an unexpected or uncontrollable natural event of unusual magnitude that threatens the activities of people or people themselves.

Natural Disaster is a natural hazard event, such as a flood or tornado, which results in widespread destruction of property or caused injury and/or death.

PDM Pre-Disaster Mitigation Program

PDM/C Pre-Disaster Mitigation Program Competitive Grants (national competitive program)

RPAs Regional Planning Agencies

Risk is the likelihood and probability of loss

SBA Small Business Administration

SHMO State Hazard Mitigation Officer

Technological hazard is a hazard that originates in accidental or intentional human activity (oil spill, chemical spill, building fires, terrorism, etc.)

Technological disaster is a disaster that results from a technological, or man-made technological hazard event.

1. Foreword

The Commonwealth of Massachusetts has been a leader in the field of hazard mitigation since the beginning of national hazard mitigation strategies over 25 years ago. Massachusetts joined the National Flood Insurance Program (NFIP) in 1978, the first year of the program. Today, more than 94% of Massachusetts' 351 communities participate in the NFIP program. In 1986, Massachusetts also was one of the first states to receive FEMA approval for its State Hazard Mitigation Plan.

Over the years, the dedicated staffs of both the Massachusetts Department of Conservation and Recreation (DCR), formerly known as the Department of Environmental Management (DEM), and the Massachusetts Emergency Management Agency (MEMA), have contributed to the success of the statewide hazard mitigation program. It was under the leadership of the state's first State Hazard Mitigation Officer, Richard Thibedeau, which the state program developed and secured additional funding for critical hazard mitigation projects throughout the state. This 2004 update is dedicated to Richard Thibedeau for his leadership, wisdom and friendship in developing the State Hazard Mitigation Team and for making hazard mitigation a vital component to all state and federal emergency management operations in Massachusetts.

The current process of updating the State Hazard Mitigation Plan as well as FEMA's Map Modernization Program in 2004 has allowed Massachusetts to research, update and analyze past and current information as well as bring new partners into the statewide planning process.

In addition, this state plan supports Massachusetts' successful hazard mitigation program by incorporating the following information required under the Disaster Mitigation Act of 2000 (DMA 2000), 44 CFR Part 201.4, Interim Final Rule, for State Hazard Mitigation Plans:

(1) An adoption process on the state, regional and local levels (Sections 2, 3, 6)
(2) Assurances that the state will comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding (Section 2),
(3) A description of an effective statewide planning process used to develop this plan (Section 3),
(4) Identification and risk assessment of natural hazards which provide the factual basis for activities proposed in the mitigation strategy section (Section 4),
(5) A capabilities assessment of current and past hazard mitigation programs, regulations, plans, resources and success stories (Section 5),
(6) A statewide mitigation strategy that provides a blueprint for reducing future losses identified in the risk assessment and the capabilities assessment (Section 5),
(7) A coordination of local and regional mitigation planning throughout the state (Section 6),
(8) A maintenance process for monitoring, evaluating and updating the plan, including reviewing and updating the State Mitigation Plan every three (3) years with submittal to FEMA/Region I. (Section 7).

2. Executive Summary

The Commonwealth of Massachusetts is vulnerable to and has experienced damage from several different types of natural hazards. Out of all the natural hazards that may affect Massachusetts, flooding is the primary natural hazard followed by wind-related and winter-related hazards. Since1972, Massachusetts has experienced 29 major disaster declarations, including 19 federal, or Presidential, disaster declarations, and 10 state disaster declarations. Since 1991, more than $246 million in federal aid and more than $20 million in state aid has been disbursed to assist Massachusetts residents in recovering from floods, hurricanes, coastal storms, winter storms/blizzards, tornadoes and wildfires. Out of these 29 disaster declarations, 18 events (62%) included major flooding, 7 events (24%) involved high winds, and 7 events (24%) were blizzards or major snowstorms.

The Commonwealth of Massachusetts established its commitment to hazard mitigation more than 25 years ago when it joined the National Flood Insurance Program (NFIP), and later when the state developed its first State Mitigation Hazard Mitigation Plan in 1986. Following subsequent disaster declarations, the Commonwealth updated its State Hazard Mitigation Plan in 1989, 1993, 1998 and 2000. Each of these plans identified the natural hazards, assessed vulnerability to the most frequent hazards, examined existing capabilities, developed statewide mitigation goals and strategies, and established a framework for implementing those goals and strategies.

One of the strongest partnerships that have grown out of this program has been the daily, cooperative relationship between the Massachusetts Emergency Management Agency (MEMA) and the Department of Conservation and Recreation (DCR). These agencies comprise the State Hazard Mitigation Team and lead the State Interagency Hazard Mitigation Committee. With the NFIP and the state plan as a mitigation program cornerstone, and with the establishment of federal mitigation grant programs in the mid-1990s, Massachusetts has been successful in leveraging federal funding for effective hazard mitigation projects. Between 1991 and 2004, the State Hazard Mitigation Team has assisted communities and other government agencies in obtaining more than $26 million in federal hazard mitigation grants to complete 161 mitigation projects and plans.

The hazard mitigation goal for Massachusetts is: **Reduce the statewide loss of life, property, infrastructure, and cultural resources from natural disasters through a comprehensive hazard mitigation program which involves planning, prevention and preparedness strategies.** The specific strategies and action steps are outlined in Section 5.4 of the plan. Under the Disaster Mitigation Act of 2000 (DMA 2000) and the Pre-Disaster Mitigation Program (PDM), Massachusetts has developed a statewide pre-disaster hazard mitigation planning strategy to support this goal through the development of multi-jurisdictional plans by regional planning agencies in partnership with the communities within each agency's jurisdiction. The goal is to have all 13 regional planning agencies and the majority of Massachusetts communities participate in these plans no later than 2007 in order to meet the regional and local planning requirements of the Disaster Mitigation Act of 2000 (see Section 3.2, Statewide Hazard Mitigation Planning Process). Prevention strategies focus on working toward improved coordination and cooperation among state agencies in implementing sound hazard mitigation planning and project development, building on the success of the State Interagency Hazard Mitigation Committee. Lastly, the Commonwealth will support, by aggressive pursuit of all available funding sources, the implementation of cost-effective preparedness and mitigation projects identified through the regional and local mitigation planning process.

2.1. Purpose

The purpose of this plan is to help the Commonwealth of Massachusetts and its residents to understand when, where, why and how natural hazards occur in order to minimize the impacts of such events and to reduce the cost of rebuilding. This plan also outlines specific actions that must be taken by the federal, state and local governments as well as the general public in order to manage the risks of natural hazards and reduce future costs of rebuilding.

This document is an update of the Massachusetts State Hazard Mitigation Plan (formerly known as the 409 Plan), in compliance with the Disaster Mitigation Act of 2000, or DMA2000, (Public Law 106-390), and implementing regulations found at 44 CFR Parts 201 and 206. Massachusetts had received FEMA Region I approval of its State Hazard Mitigation Plan in 1998 and 2000 in compliance with the requirements at that time of 44 CFR 206.405, specifically Subpart M, Hazard Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

This update is intended to incorporate the hazard mitigation lessons learned following recent disasters in order to be better prepared for future events as well as meeting the DMA 2000 state mitigation planning requirements. This plan also accomplishes the following:

1. Expands the Commonwealth's statewide, natural hazards risk assessment;
2. Documents the statewide strategy for regional and local hazard mitigation planning mandated under the DMA 2000;
3. Gives an overview of the state's current capabilities and areas of improvement as well as strategies to improve hazard mitigation throughout the state; and
4. Provides an overview of a more than decade of successful hazard mitigation projects funded through the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA), and, most recently, the Pre-Disaster Mitigation (PDM) Program.

Photos from the Blizzard of 1978, flooding along the Massachusetts coastline and heavy snow in Boston.

2.2 Authority and Scope

Prior to 2000, Section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288, as amended) was the impetus for the involvement of state and local governments in evaluating and mitigating natural hazards as a condition of receiving federal disaster assistance. A requirement of the Stafford Act's Section 409 was the development of a state hazard mitigation plan.

A state was required to update its State Hazard Mitigation Plan per Section 409 following every Presidentially declared disaster. Massachusetts updated, and received FEMA approval, of its state plan following Presidential disaster declarations in 1986, 1987, 1989, 1993, and 1998. In addition, Massachusetts' State Hazard Mitigation Plan was again reviewed and approved by FEMA Region I in late 2000.

The Disaster Mitigation Act of 2000 (Public Law 106-390) , signed by the president on October 30, 2000, with its Interim Final Rules, 44 CFR Part 201 and 206, *Hazard Mitigation Planning and Hazard Mitigation Grant Program,* eliminated the state mitigation update requirement following each Presidentially declared disaster. Instead, states must now complete, and receive FEMA approval, of its updated State Mitigation Plans by November 1, 2004 with an update cycle of every three years. These new regulations also provide specific requirements for the content of State Hazard Mitigation Plan.

Additional information on the Robert T. Stafford Disaster Relief and Emergency Assistance Act and the Disaster Mitigation Act may be found in Appendix A, Federal & State Regulations.

2.3 Adoption by the State

This State Hazard Mitigation plan has been reviewed by the State Interagency Hazard Mitigation Committee, a standing committee of various state and federal agencies as well as private organizations involved in hazard mitigation following recent Presidential Disaster Declarations (see committee member list in Appendix E). After this review and approval process as described in Section 3 of this plan, the two primary state agencies responsible for hazard mitigation in Massachusetts – the Massachusetts Emergency Management Agency (MEMA) and the Department of Conservation and Recreation (DCR), formerly the Department of Environmental Management – reviewed and approved this plan. The Director of MEMA and the Commissioner of DCR both reviewed and approved this. The letters of approval and assurance are presented in the front of this plan.

3. The Planning Process

Before reviewing the planning process in Massachusetts, it is important to understand the structure of state and local government in this "commonwealth" – a structure which is intrinsic to New England, but very different from the rest of the United States. This section provides the following:

1. An profile of Massachusetts, including demographics, topography and government structure
2. A description of the statewide planning strategy
3. An overview of the statewide planning process, including coordination with state agencies.

3.1 A Profile of Massachusetts

(Source of the following information on Massachusetts www.mass.gov, official website of the Commonwealth of Massachusetts, July 2004)

Massachusetts is one of the original 13 states (6th) of the Union (February 6, 1788). Boston, the capital of Massachusetts since its founding, dates from 1630.

Official Name: Commonwealth of Massachusetts
Nickname: Bay State
Capital: Boston
Motto: Ense Petit Placidam Sub Libertate Quietem (Translation: By the Sword We Seek Peace, But Peace Only Under Liberty)
Population: 6,349,097 (2000 Census)

Massachusetts has a gross area of 8,257 square miles and a net land area of 7,838, and ranks 13th in population and 45th in area among the states of the nation. It is divided into 14 county areas, varying in size and population from Nantucket (area 50.34 sq. mi., pop. 9,520) to Worcester (area 1575.95 sq. mi., pop. 750,963) and Middlesex (area 844.21 sq. mi., pop. 1,465,396).

The counties are made up of 49 cities and 302 towns, of which Boston with a population of 589,141 is the largest and Gosnold, with a population of 86, is the smallest. More than half of Massachusetts total population lives in the Greater Boston area. Other Massachusetts cities over or approximating 100,000 populations are:

Chief cities and their populations as of the U.S. Census 2000:

1. **Boston: 589,141**
2. **Worcester: 172,648**
3. **Springfield: 152,082**
4. **Lowell: 105,167**
5. **Cambridge: 101,355**
6. **New Bedford: 93,768**
7. **Brockton: 94,304**
8. **Fall River: 91,938**
9. **Lynn: 89,050**
10. **Quincy: 88,025**

A third of the population has not been born in the United States. Of the total 2000 population, 55.2% identified with a single ancestry group, 33% with the multi-ancestry group, and 11.7% were not specified. Of the single ancestry groups, the six leading groups were: Irish (21%), English (14.5%), Italian (13.6%), French (9.9%), Portuguese (6%) and Polish (5.1%). In 2000, African-Americans comprised 5.4%, Hispanics 6.8%, Native Americans .2%, and Asians 3.8% of the State.

According to U.S. Census data from 1970 – 2000, Massachusetts' population grew by 11.6%, or by 659,927 people during this 37 year time frame. There was minimal growth of .8% from 1970 – 1980, but the next two decades in the 1980s and 1990s, population growth has increased 4.9% to 5.5% respectively. The population growth in all of Massachusetts' 79 coastal communities basically mimicked the overall state population increases, growing at slightly slower rates. For more information on Massachusetts demographics, see Appendix D, Massachusetts Communities and Demographics.

General Overview of Massachusetts Topography

Area: 8,257 square miles (land and water)
Largest body of water: Quabbin Reservoir (39 sq. miles)
Longest river: Charles River (80 miles)
Highest elevation: Mt. Greylock (3,491)
Lowest elevation: Atlantic Ocean (sea level)
Number of state parks: 107
Largest state park: October Mountain State Forest, Lee (15,710 sq. acres)
Number of national historical parks, seashores and historic sites: 12
Largest national area: Cape Cod National Seashore (43,500 sq. acres)

Rivers

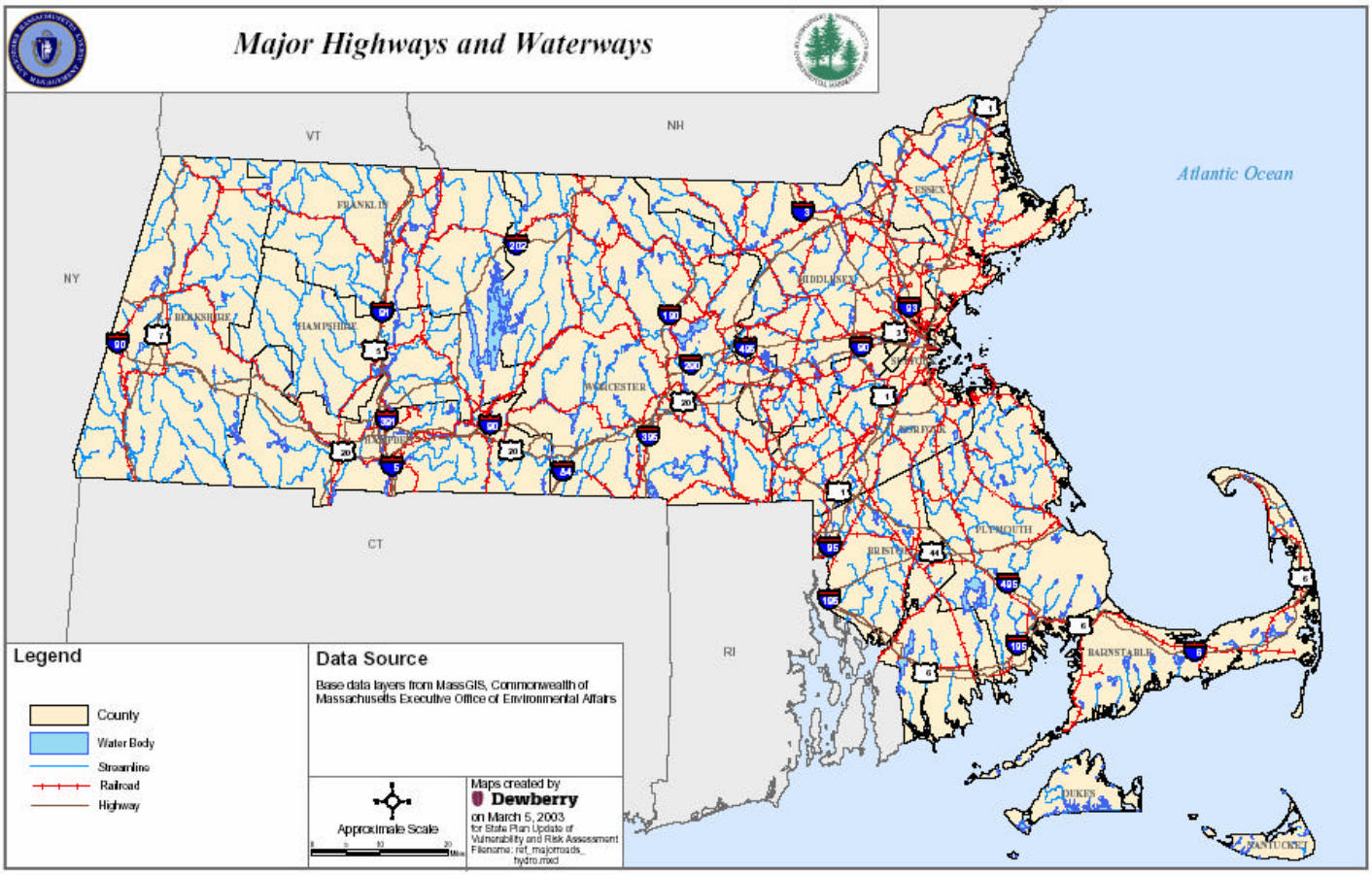
There are 4,230 miles of rivers within the Commonwealth of Massachusetts. The largest is the Connecticut, which flows from north to south. Its tributaries are the Deerfield, Westfield, Chicopee, and Miller's rivers. In the far western part of the state the Housatonic River flows south and the Hoosic River flows north between the Hoosic and Taconic mountain ranges.

The Merrimack River, in the northeast, rises in New Hampshire and empties into the Atlantic Ocean. It is navigable for shipping up to a distance of about 15 miles from its mouth. The Nashua and Concord rivers are tributaries of the Merrimack. The Blackstone River flows south from the center of Massachusetts. The Mystic and Charles rivers flow into Boston Harbor, and the Taunton River enters Mount Hope Bay at Fall River.

Lakes

Massachusetts has more than 1,100 lakes and ponds. The largest of these, Quabbin Reservoir (24,704 acres) and Wachusett Reservoir (4,160 acres) are manmade. These two reservoirs will provide Metropolitan Boston with most of its water for many years to come.

The largest lakes of natural origin are Assawompsett Pond (2,656 acres) in Lakeville and Middleborough, drained by the Taunton River; North Watuppa Pond (1,805 acres) and South Watuppa Pond (1,551 acres) in Fall River and Westport, drained by the Quequechan River; Long Pond (1,361 acres) in Lakeville and Freetown, drained by the Taunton River; Lake Chargoggagogmanchaugago gchaubunagungamaug (1,188 acres) - usually and mercifully called Lake Webster - in Webster, drained by the French River; Herring Pond (1,157 acres) in Edgartown on the island of Martha's Vineyard; Great Quittacas Pond (1,128 acres) in Lakeville, Rochester and Middleborough, drained by the Taunton River; Lake Quinsigamond (1,051 acres) in Worcester, Shrewsbury, and Grafton; and Monponsett Pond (756 acres) in Halifax and Hanson, drained by the Taunton River.



For larger versions of the maps of Massachusetts cities and towns and major highways and waterways, see Appendix E.

Islands

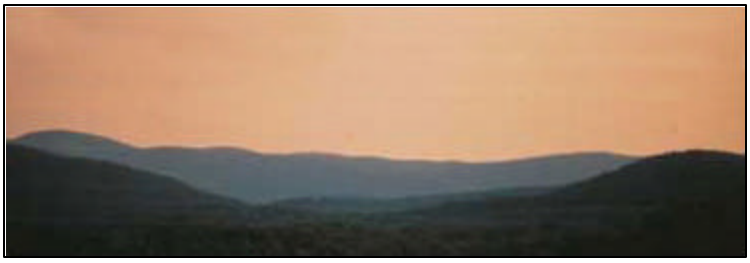
Lying off Cape Cod are Martha's Vineyard, Nantucket, and the Elizabeth Island group. Martha's Vineyard, triangular in shape, is about 19 miles long and less than 10 miles in width. It contains the towns of Edgartown, Chilmark, Tisbury, West Tisbury, Gay Head, and Oak Bluffs.

Nantucket, also roughly triangular, about 15 miles long and from three to four miles wide, was once famed for its whaling industry. Both Martha's Vineyard and Nantucket are now popular summer resorts. The Elizabeth Islands are a group of about 22 small islands lying between Vineyard Sound and Buzzards Bay. On one of those, Cuttyhunk, Bartholemew Gosnold established a colony in 1602, abandoning it the same year.

The Boston Harbor Island group includes The Four Brewsters, Bumpkin, Calf, Deer, Gallop's, George's (used for thousands of Confederate prisoners of war during the Civil War), Grape, The Graves, Green, Hangman, Long, Lovell's, Nixes Mate, Paddock's, Raccoon, Rainsford, Sheep, Slate, Spectacle and Thompson. Some islands have been made part of the mainland by the great amount of landfill that has gone on over the years. Governor's Island, where the first apple and pear trees in America were planted, is now a part of Boston's Logan International Airport. Most of the islands have been used for farming, resort-recreation areas, public facilities, or fortifications.

Mountains

Massachusetts landscape was extensively re-formed during the last Ice Age; the only substantial ranges left are the Berkshire Hills and the Blue Hills. Mount Greylock, altitude 3,491 feet, in Berkshire County, is the highest mountain in Massachusetts. Other important mountains are Mount Williams (2,951 feet) in North Adams; East Mountain (2,660 feet) in Hancock; Mount Everett (2,602 feet) in Mt. Washington; Spruce Hill (2,588 feet) in Adams; Mount Frissel (2,453 feet) in Mt. Washington; Potter Mountain (2,391 feet) in Lanesboro; French Hill (2,214 feet) in Peru; and Mount Wachusett (2,006 feet) in Princeton.



Government Structure in Massachusetts

As a “home rule” state, the Commonwealth of Massachusetts structure of state and local government has a tremendous impact on its statewide hazard mitigation planning. It is important to understand the Commonwealth’s history, state and local government structure, current and future demographics and topography before one can understand the Statewide Hazard Mitigation Planning Strategy.

State Government

The Massachusetts Constitution was ratified in 1780 while the Revolutionary War was still in progress, nine years before the United States Constitution was adopted. It is the oldest written Constitution now in use in the world. It specified three branches of Government: Executive, Legislative, and Judicial.

Massachusetts, like Pennsylvania, Virginia, and Kentucky, is called a "Commonwealth". Legally, Massachusetts is a commonwealth because the term is contained in the Constitution. In the era leading to 1780, when the state Constitution was ratified, a popular term for a whole body of people constituting a nation or state was the word "Commonwealth." This term was the preferred usage of some political writers. There also may have been some anti-monarchic sentiment in using the word "Commonwealth." The name, which in the eighteenth century was used to mean "republic", can be traced to the second draft of the state Constitution, written by John Adams and accepted by the people in 1780. In this second draft, Part Two of the Constitution, under the heading "Frame of Government", states, "that the people...form themselves into a free, sovereign, and independent body politic, or state by the name of The Commonwealth of Massachusetts." The people had

overwhelmingly rejected the first draft of the Constitution in 1778, and in that draft and all acts and resolves up to the time between 1776 and 1780, the name "State of Massachusetts Bay" had been used.

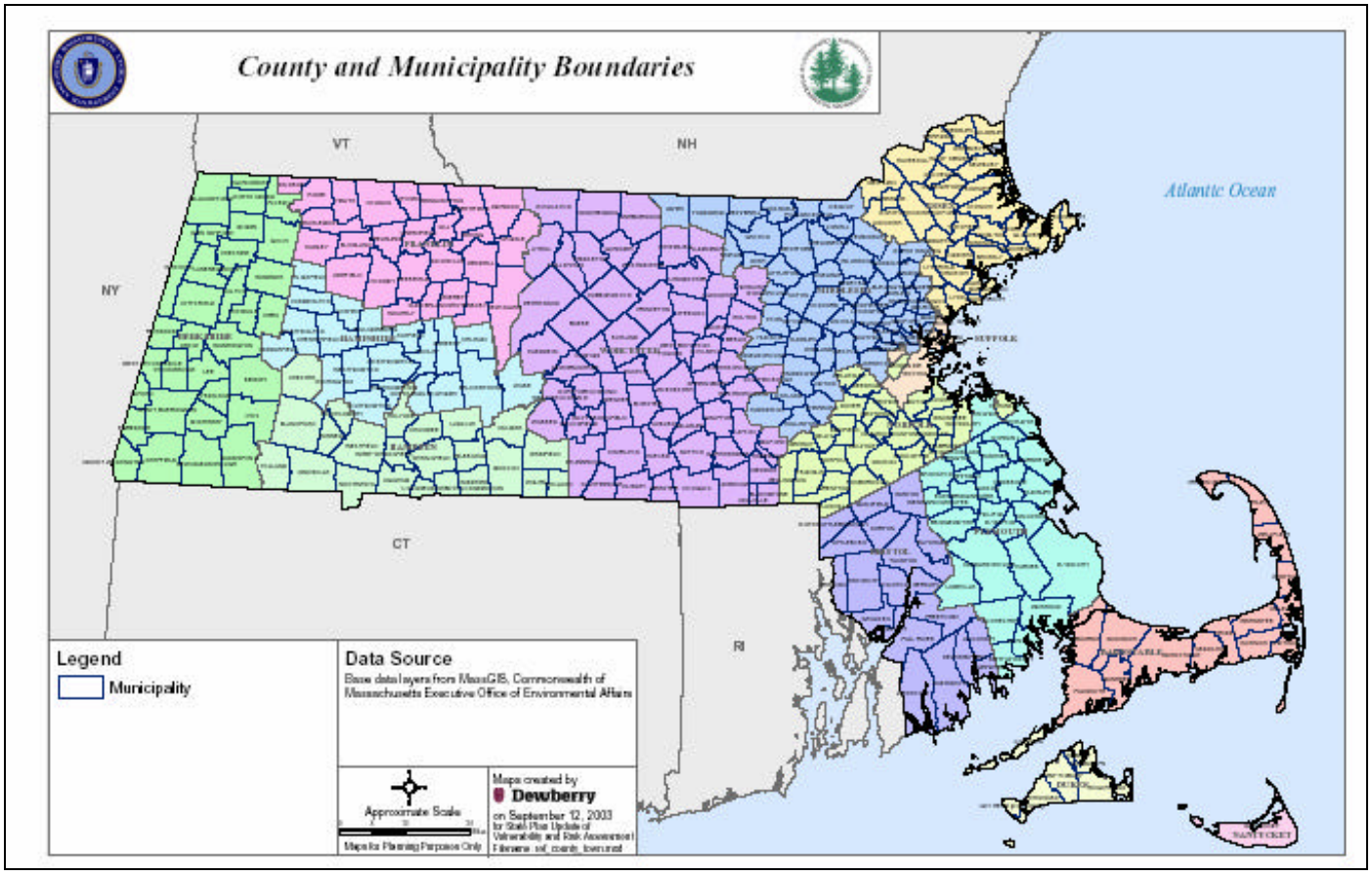
Current Organization of State Government

Executive Office: Six constitutional officers elected for four years: Governor, Lieutenant Governor, Secretary of the Commonwealth, Attorney General, Treasurer and Receiver General, Auditor. The Constitutional Officers are:

Governor: Mitt Romney
Lieutenant Governor: Kerry M. Healey
Secretary of the Commonwealth: William Francis Galvin
Treasurer and Receiver General: Timothy P. Cahill
Attorney General: Thomas Reilly
Auditor: A. Joseph DeNucci

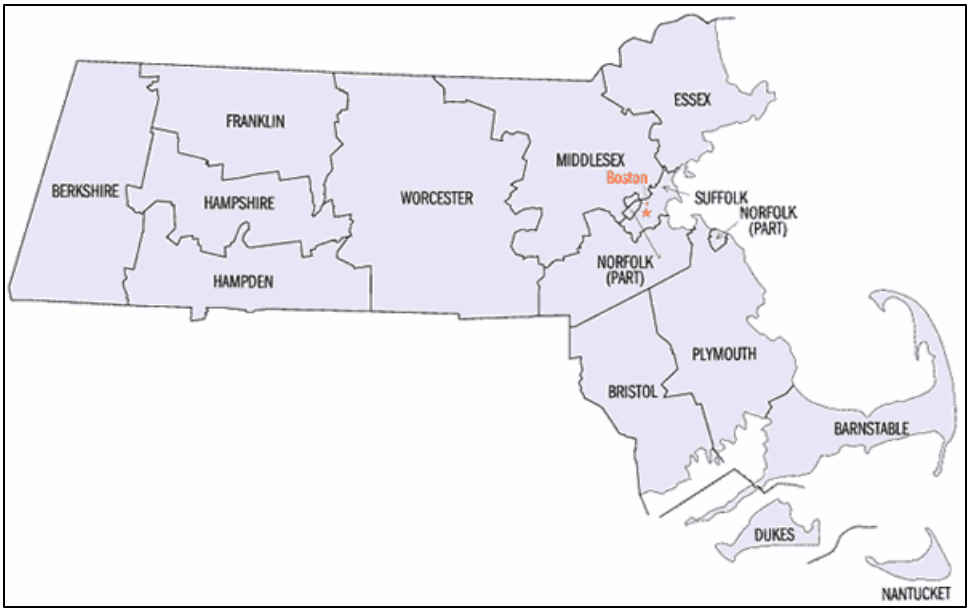
Legislature:
Official Name: General Court
Senate: 40 members elected every two years.
House of Representatives: 160 members elected every two years.

Highest Court - Supreme Judicial Court: Chief Justice Margaret H. Marshall and five Associate Justices. All are appointed by the Governor with the advice and consent of the Executive Council.



Counties

County government in Massachusetts, as in all of New England, is not a strong entity. The county level of government is not mentioned in the state Constitution, and was later established by legislative action. The fourteen counties, moving roughly from west to east, are Berkshire, Franklin, Hampshire, Hampden, Worcester, Middlesex, Essex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Dukes and Nantucket. Traditionally, each has been served by three County Commissioners with the exception of Nantucket and Suffolk. The five town selectmen of Nantucket serve as Commissioners; Suffolk's Commissioners are the Mayor and City Council of Boston.



In 1985, the state Legislature passed laws allowing counties, under certain circumstances, to adopt "home rule" charters which would change the form, structure, and organization of county government. In 1988, six counties placed home rule questions on their ballots, and Barnstable and Hampshire county voters voted for the question. Therefore, Barnstable County on Cape Cod is now governed by an elected fifteen member Assembly of Delegates and an eleven member Board of County Commissioners. An elected Board of County Commissioners, assisted by an appointed County Administrator, governs Hampshire County in western Massachusetts.

Municipalities

There are a total of 351 cities and towns in Massachusetts, each with their own governing body. Massachusetts cities are governed by elected Mayors and City Councils, but towns are usually governed by groups of elected officials called Selectmen. A Board of Selectmen is usually elected for a one-or-two-year term, and annual town meetings, a tradition from Colonial times. A current listing of state, county and municipal government agencies and contacts may be found at the Commonwealth of Massachusetts in Appendix B and on the internet at **www.mass.gov**.

3.2 Statewide Hazard Mitigation Planning Process

The following section provides a chronological overview of the hazard mitigation planning process from 1997 to 2004 in Massachusetts as well as a strategy for the next 5 years. This includes an overview of completed mitigation plans in Massachusetts, past activities that have helped to promote hazard mitigation planning throughout the state, and the current strategy to complete "all hazard" mitigation plans for all Massachusetts communities.

1997 – 2002 Hazard Mitigation Planning in MA

Prior to the establishment of the Pre-Disaster Mitigation (PDM) Program, the state actively pursued available hazard mitigation planning funds through the Flood Mitigation Assistance Program (FMA) and the Hazard Mitigation Planning Program. With annual Flood Mitigation Assistance (FMA) Program planning funds since 1997 and Hazard Mitigation Grant Program (HMGP) 7% funding following the March 2001 floods, Massachusetts has funded the following mitigation plans:

FMA & HMGP Funding of Local Flood Mitigation Plans 1997 – 2002

Year	Plan Funding (75%)	Funding Source	Communities Awarded Planning Funds
1997	$27,800	FMA	Braintree Plymouth Tewksbury
1998	$10,800	FMA	Peabody
1999	$49,000	FMA	N. Reading Revere Salisbury Scituate
2000	$30,700	FMA	Sandwich Westwood Weymouth
2001	$35,935 $45,000 ($15,000 for each community)	FMA HMGP	N. Andover Northampton Wilbraham Framingham Melrose Marblehead
Total	***$199,235***		***17***

1998 MA Holds New England's First Mitigation Planning Workshop

In August 1998, the state developed and hosted New England's first hazard mitigation planning workshop with funding from FEMA/Region I. Entitled, ***Community-Based Hazard Mitigation Planning: Lowering the Risks and Costs of Disaster,*** this training workshop attracted over 100 planners and emergency managers from federal, state and local governments as well as non-profit and private organizations. Part of this

workshop included the sharing of a state developed planning guide, created by the then-Department of Environmental Management Floodplain Management Staff. The guidebook, entitled, ***Flood Hazard Mitigation Planning: A Community Guide***, was given to all the workshop participants. In 2002, this guidebook was updated by the state to include "all hazards" and is currently being used as the planning guide for developing all hazard mitigation plans.

This guidebook is also available on the internet and may be downloaded off of the state's Hazard Mitigation website at www.state.ma.us/dem/programs/mitigate/guide.htm. The state also developed a webpage in 1999 as link off of both MEMA's and DCR's websites, in order to provide the latest information about hazard mitigation programs, planning and grant availability. This page continues to be maintained and updated by the State Hazard Mitigation Staff.

2002 - Developing a Strategy to Meet New Planning Requirements

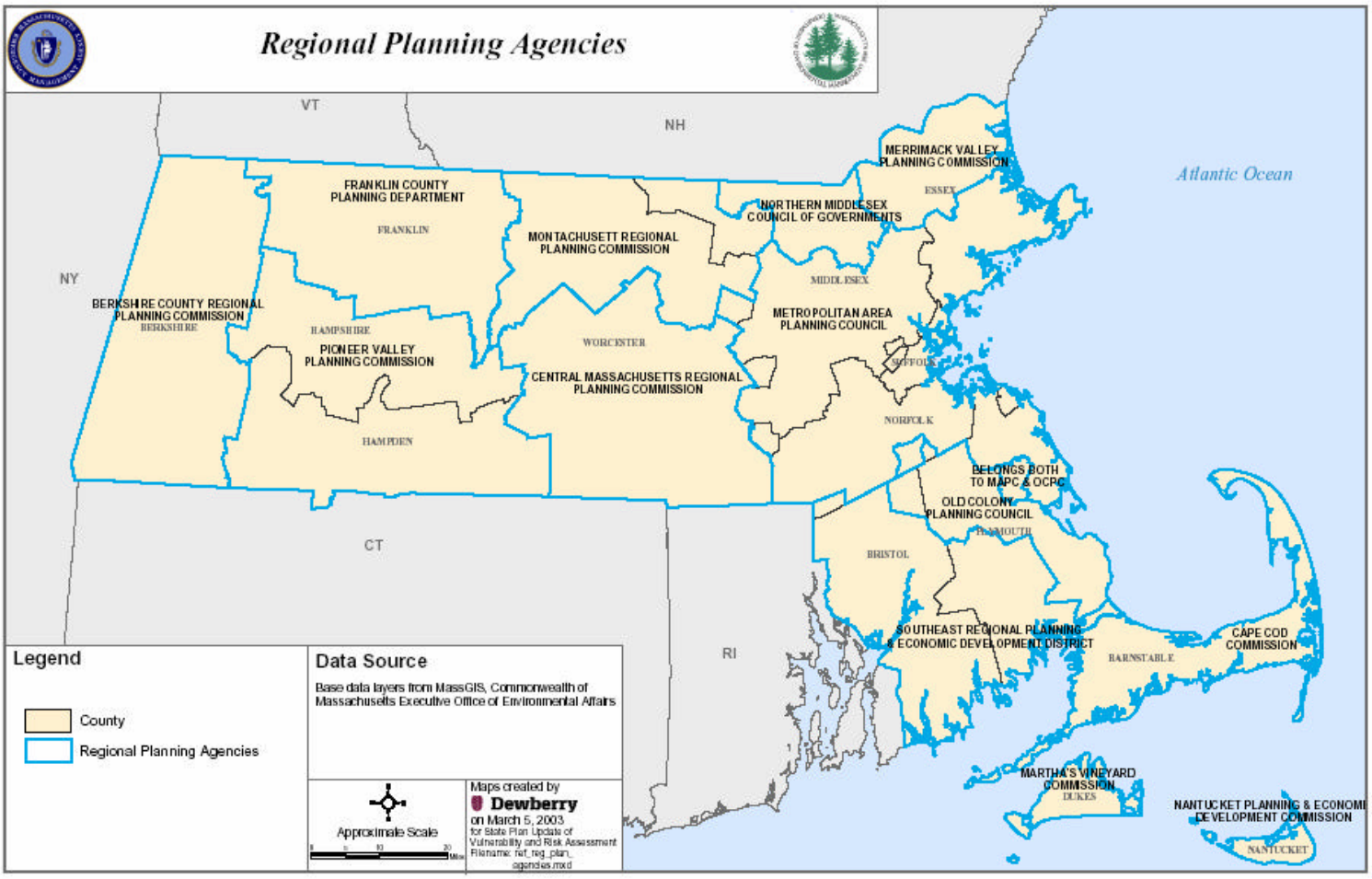
In 2002, the state was faced with developing the best approach to distribute $350,000 in PDM planning funds to assist Massachusetts communities meet the DMA 2000 planning requirements. The state began work in mid-2002 to develop a statewide planning strategy that would optimize current and future FEMA funding for developing "all natural hazards" mitigation plans. The state also realized that, in addition to the PDM funds, planning funds could also be utilized from the Hazard Mitigation Grant Program (HMGP) and the Flood Mitigation (FMA) Assistance Program.

Because of Massachusetts' strong home-rule style of local government and the current lack of county governments, the State Hazard Mitigation Team and State Interagency Hazard Mitigation Committee reviewed several options and eventually made the decision to work on a regional basis with regional planning agencies (RPAs). In Massachusetts, RPAs are quasi-government agencies that work with multiple local governments and coordinate federal, state and local resources, such as transportation studies, in a regional manner.

There are a total of 13 RPAs within the Commonwealth of Massachusetts. As regional and local mitigation plans are developed over the next few years, the information gathered on communities and regions, especially critical infrastructure and risk assessment data, will be incorporated into this State Hazard Mitigation Plan and shared with all interested federal, state and local agencies as well as private partners. The RPAs in Massachusetts are as follows:

1. Berkshire Regional Planning Commission (BRPC)
2. Cape Cod Commission (CCC)
3. Central Massachusetts Regional Planning Commission (CMRPC)
4. Franklin Regional Council of Governments (FRCOG)
5. Martha's Vineyard Commission (MVC)
6. Merrimack Valley Planning Commission (MVPC)
7. Metropolitan Area Planning Council (MAPC)
8. Montachusett Regional Planning Commission (MRPC)
9. Nantucket Planning and Economic Development Commission (NP&EDC)
10. Northern Middlesex Council of Governments (NMCOG)
11. Old Colony Planning Council (OCPC)
12. Pioneer Valley Planning Commission (PVPC)
13. Southeastern Regional Planning and Economic Development District (SRPEDD)

The following map shows the geographic areas covered by these RPAs. A larger version of this map and more information on the individual RPAs may be found in Appendix E.



2002 – 2003 The Regional Planning Agency Selection Process

Massachusetts' statewide hazard mitigation planning process began in early 2002. This process began with a series of meetings and individual consultations, which involved the following activities and groups:

1. The State Hazard Mitigation Team which consists of full-time staff members with the Massachusetts Emergency Management Agency (MEMA) and the Department of Conservation and Recreation (DCR),
2. The State Interagency Hazard Mitigation Committee which includes federal, state and local agencies as well as private sector representatives (see organizational chart on page 25),
3. The Dewberry Company for contract work to develop GIS risk assessment maps and a statewide analysis of state-owned facilities (this risk assessment is outlined in Section 5 of this plan and is found in Appendix G),
4. A hazard mitigation focus group for local and state officials and representatives from the 13 regional planning agencies held on May 8, 2002.

With information and feedback gathered from the aforementioned meetings and studies, the State Hazard Mitigation Team considered several options on developing a regional planning approach and distributing the available planning funds. The potential options considered included:

1. Fund all 13 RPAs to initiate but not complete the planning process, based on a formula which includes demographics and a measure of risk. This option would have initiated the planning process in each RPA, but would have necessitated identification of additional funding sources, or else result in no plans being completed.

2. Fund 8 to 12 of the RPAs to conduct a full risk assessment for their entire planning area, and develop regional mitigation strategies.

3. Fund 5 to 10 of the RPAs to conduct a full risk assessment for their entire planning area, and complete local plans for a sub-part of their planning area

4. Fund 3 to 6 of the RPAs to conduct a full risk assessment and complete local plans for their entire planning area.

After much discussion, Option 4 was selected by the State Hazard Mitigation Team as the preferred option. While there were definitely advantages to initiating the process with all 13 RPAs, it was felt that Option 1 had too high a risk of ending up with very few completed plans, particularly since there are no assurances that PDM funding would be available in future years. While Option 2 would have brought each of the selected RPAs to a logical stopping point (identification of regional strategies that could then be passed on to the communities), the risk was also considered too high that very few communities would pick up the process at this point and complete local plans. Option 3 was discussed at length and was very seriously considered. The advantages were that the Team could work with more RPAs than in Option 4, and thus cover more of the state, although admittedly more thinly.

The State Mitigation Team eventually decided that given the limited cost estimate data the state had, it would be extremely difficult to establish a suitable sub-region size for all of the RPAs and develop a cost estimate for each RPA. The Team further decided that Option 4 would likely produce the greatest number of completed plans (and/or plans completed for the highest risk areas), and also that limiting the number of RPAs chosen would allow for greater efficiency in terms of training and technical assistance provided by FEMA, MEMA, and DCR to the RPAs.

The state met with 4 RPAs in June 2002 (SRPEDD, Old Colony, Northern Middlesex COG, and MAPC) in order to gain feedback from a variety of RPAs on regional cost estimates for plan research and development. The cost estimates provided a range to work from and helped to further refine the number of RPAs that could receive funding within the available allocation.

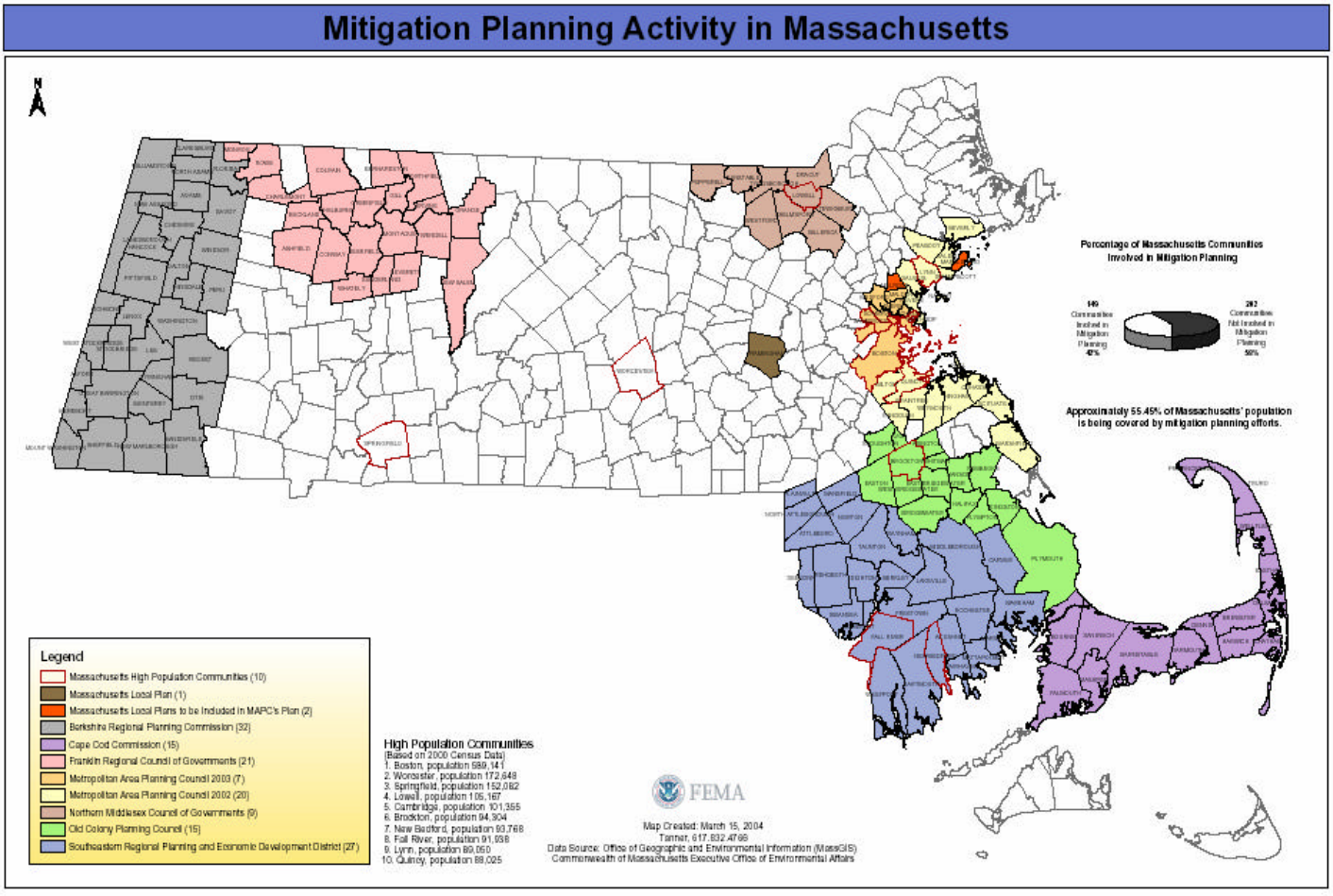
Once Option 4 was agreed upon, the Team had to develop selection criteria for determining which RPAs should receive PDM grants. It was felt that risk would be the primary factor to use in the selection process. Using a table of relative occurrences of natural hazards in each planning area, the top three RPAs were the Metropolitan Area Planning Council (MAPC), Franklin Regional Council of Governments (FRCOG), and the Southeastern Regional Planning and Economic Development District (SRPEDD). The Team believed that the state could begin with those three (recognizing that MAPC is so large that an appropriate sub-region would need to be selected), then felt that adding the Cape Cod Commission (CCC) made sense because the state could get completed plans for lower cost since much of the CCC risk assessment work had already been completed under Project Impact.

2002 & 2003 Allocations to Regional Planning Agencies

With the 2002 Pre-Disaster Mitigation (PDM) program funding, and additional funding received in 2003, Massachusetts has been able to fund seven RPAs to complete regional multiple hazard plans which will include local annexes for up to 140 communities. The chart on the next page gives an overview of the seven Massachusetts RPAs funded to date, the amount of federal and local funding, the communities within each RPA jurisdiction and when the final multi-jurisdictional plans are due.

MARPA is the Massachusetts Association of Regional Planning Agencies

The map below shows the coverage area of the currently funded RPAs as well as the Commonwealth's other planning efforts which have been funded by the Pre-Disaster Mitigation (PDM) Program, the Flood Mitigation Assistance (FMA) Program and the Hazard Mitigation Grant Program (HMGP), as of the end of 2003. Since 2002, Massachusetts has awarded two FMA planning to the Berkshire Regional Planning Commission and the Northern Middlesex Planning Commission in order to complete the flood portion of the regional all hazards mitigation plan. A larger version of this map, prepared by FEMA Region I, may be found in Appendix E.



Funding of Regional Planning Agencies in 2002 & 2003

Regional Planning Agency & Funding	# Communities	Population 2000 Census	*Total Sq. Mileage*	*Counties Served*	*Communities Within Each Regional Planning Agency's Jurisdiction*
Berkshire Regional Planning Commission (BRPC) ***PDM Federal: $58,915*** ***PDM Local: $14,729*** ***FMA Federal: $33,600*** ***FMA Local: $11,200*** **Final Plan Due: July 2005**	32	135,000	945	Berkshire	Adams, Alford, Becket, Cheshire, Clarksburg, Dalton, Egremont, Florida, Great Barrington, Hancock, Hinsdale, Lanesborough, Lee, Lenox, Monterey, Mt. Washington, New Ashford, New Marlborough, North Adams, Otis, Peru, Pittsfield, Richmond, Sandisfield, Savoy, Sheffield, Stockbridge, Tyringham, West Stockbridge, Washington, Williamstown, Windsor
Cape Cod Commission (CCC) ***Federal: $40,000*** ***Local: $13,333*** **Final Plan Due: December 2004**	15	222,230	395	Barnstable	Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, Yarmouth
Franklin Regional Council of Governments (FRCOG) ***Federal: $59,250 (2002)*** ***Local: $19,750*** ***Federal: $59,898 (2003)*** ***Local: $19,996*** **Final Plans Due: December 2004 July 2005**	26	71,535	740	Franklin	Ashfield, Bernardston, Buckland, Charlemont, Colrain, Conway, Deerfield, Erving, Gill, Greenfield, Leverett, Monroe, Montague, New Salem, Northfield, Orange, Rowe, Shelburne, Sunderland, Wendell Whately
Metropolitan Area Planning Council (MAPC) ***Federal: $153,750*** ***Local: $51,250*** **Final Plan Due: December 2004**	101	3,066,394	1400	Essex, Middlesex, Norfolk, Plymouth, Suffolk & Worcester	North: Beverly, Lynn, Marblehead, Nahant, Peabody, Revere, Salem, Saugus, Swampscott, Winthrop, South: Braintree, Cohasset, Hingham, Hull, Marshfield, Milton, Quincy, Randolph, Scituate and Weymouth
Northern Middlesex Council of Governments (NMCOG) ***PDM Federal: $25,000*** ***PDM Local: $8,333*** ***FMA Federal: $29,800*** ***FMA Local: $9,933*** **Final Plan Due: July 2005**	9	281,225	200	Middlesex	Billerica, Chelmsford, Dracut, Dunstable, Lowell, Pepperell, Tewksbury, Tyngsborough and Westford
Old Colony Planning Council (OCPC) ***Federal: $79,725*** ***Local: $19,932*** **Final Plan Due: July 2005**	15	321,515	346	Plymouth, Norfolk	Abington, Avon, Bridgewater, Brockton, East Bridgewater, Easton, Halifax, Hanson, Kingston, Pembroke, Plympton, Plymouth, Stoughton, West Bridgewater, Whitman
Southeastern Regional Planning and Economic Development District (SRPEDD) ***Federal: $100,000*** ***Local: $33,334*** **Final Plan Due: December 2004**	27	597,294	808	Bristol, Norfolk & Plymouth	Acushnet, Attleboro, Berkley, Carver, Dartmouth, Dighton, Fairhaven, Fall River, Freetown, Lakeville, Mansfield, Marion, Mattapoisett, Middleborough, New Bedford, North Attleborough, Norton, Plainville, Raynham, Rehoboth, Rochester, Seekonk, Somerset, Swansea, Taunton, Wareham, Westport

.

Future Funding of Regional Planning Agencies (RPAs)

As funding under the Pre-Disaster Mitigation (PDM) Competitive Grant Program becomes available from FEMA after FY2004, Massachusetts intends to apply for future funding to underwrite the remaining six RPAs in order to complete regional and local hazard mitigation plans. The ultimate goal is for all 351 Massachusetts communities to have technical assistance provided to them to assist in completing a community annex as part of one of the 13 regional, multi-hazard plans. By December 2004, the State Hazard Mitigation Team anticipates the completion and FEMA approval of three more multi-jurisdictional plans involving up to 59 communities. By the end of 2005, the State Hazard Mitigation Team anticipates the completion and FEMA approval of four multi-jurisdictional plans involving up to 71 local municipalities. If funding continues as it has over the past couple of years, Massachusetts anticipates that this goal may be achieved no later than FY 2007.

Incorporation of Regional and Local Data into the State Plan

As soon as the regional and local plans are completed, this information, especially information on estimated losses by jurisdiction, will be incorporated into this State Mitigation Plan. The schedule for incorporation information from the currently funded RPAs into the State Mitigation Plan by the State Mitigation Planning Coordinator is as follows:

Regional Planning Agency	***Plan Due Date***	***State Plan Analysis & Inclusion***
Berkshire Regional Planning Commission (BRPC)	**July 2005**	**July 2006**
Cape Cod Commission (CCC)	**December 2004**	**December 2005**
Franklin Regional Council of Governments (FRCOG)	**December 2004**	**December 2005**
Metropolitan Area Planning Council (MAPC)	**December 2004**	**December 2005**
Northern Middlesex Council of Governments (NMCOG)	**July 2005**	**July 2006**
Old Colony Planning Council (OCPC)	**July 2005**	**July 2006**
Southeastern Regional Planning and Economic Development District (SRPEDD)	**December 2004**	**December 2005**

As the remaining six RPAs are funded, a schedule for incorporation of their data into the State Mitigation Plan will be developed by the State Mitigation Planning Coordinator.

3.3 Coordination with State Agencies & Partnering with the Private Sector

The Commonwealth of Massachusetts has a unique, statewide effort of interagency cooperation in the administration and management of its Hazard Mitigation Program. This program is a joint effort between the Massachusetts Department Conservation and Recreation (DCR) and the Massachusetts Emergency Management Agency (MEMA). The team consists of the staff in DCR and MEMA working full-time on hazard mitigation programs, projects and planning, such as the National Flood Insurance Program (NFIP), the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA) and Pre-Disaster Mitigation (PDM) Program. The team is co-chaired by the State Hazard Mitigation Officer at DCR and the Disaster Recovery Manager at MEMA. This group meets on a monthly basis to coordinate team members' individual work assignments. The chart on the next page lists the team participants.

Massachusetts also has had an active State Interagency Hazard Mitigation Committee since 1991 following two Presidential Disaster Declarations after Hurricane Bob in August 1991 and the Halloween Storm in October 1991. This committee, which consists of state and federal agencies as well as private sector organizations, is responsible for identifying and addressing statewide hazard mitigation issues, policies and projects following large-scale natural disasters. The committee is responsible for reviewing and approving the State Hazard Mitigation Plan as well as reviewing and approving proposed local hazard mitigation projects funded through the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance Program (FMA) and the other available federal funding for mitigation projects, such as the recent Housing and Urban Development (HUD) Unmet Disaster Needs funding.

Members of the State Interagency Hazard Mitigation Committee include representatives from the following government agencies and private organizations:

- MA Board of Building Regulations & Standards (BBRS)
- MA Coastal Zone Management (CZM)
- DCR Water Supply Protection
- DCR Waterways
- DCR Office of Dam Safety
- DFW Riverways
- DEP Wetlands and Waterways
- MA Dept. of Housing & Community Development
- Woods Hole Oceanographic Institute
- Cape Cod Cooperative Extension
- National Fire Protection Association (NFPA)
- New England Disaster Recovery Information X-Change (NEDRIX – an association of private companies & industries involved in disaster recovery planning)
- MA Board of Library Commissioners
- MA Highway Dept.
- MA Division of Marine Fisheries
- MA Division of Capital & Asset Management (DCAM)
- Massachusetts Association of Regional Planning Agencies (MARPA)
- University of Massachusetts/Amherst
- Natural Resources Conservation Services (NRCS)

- MA Historical Commission
- U.S. Army Corps of Engineers
- Federal Emergency Management Agency

This group has been meeting at least once a year since 1991 and, following all Presidential disaster declarations in Massachusetts, the group will convene within approximately 30 days of the declaration. In addition, per a 1999 agreement with FEMA /Region I as part of the FEMA approved State Hazard Mitigation Plan (409 Plan) at that time, this committee, in partnership with FEMA/Region I, serves as the Interagency Hazard Mitigation Team, or IHMT (see description under 44 CFR 206.401) following Presidential disaster declarations in Massachusetts. Depending upon the nature of that particular disaster, additional local, state and federal agencies may be asked to be temporary IHMT members by MEMA, DEM and FEMA. If necessary, MEMA, DCR, and FEMA, within 7 days of the opening of the Disaster Field Office, will agree upon the date of the IHMT meeting and a timeline for the completion of the Early Implementation Strategy report. This meeting and report are tied into the 2000 update of the State Hazard Mitigation Plan (409 Plan).

MA Mitigation Success Story

Floodwall Prevents Flooding of Public Safety Building

A new floodwall protects the North Reading Public Safety Building from the Ipswich River. Severe storms and flooding in March 2001 tested the project that was completed just months before.

"It worked exactly how we anticipated it would work," said Michael P. Soraghan, town engineer. "We anticipated the worst possible conditions and this storm reflected that. Not only was the river rising above flood stage, but precipitation was still occurring, which necessitated using the pump."

Emergency management operations in the building remained open throughout the March flooding and the town was able to address other storm-related issues sooner because the Public Safety Building didn't have to be protected by sandbags this time. The river rose to 3 feet above the basement floor in 1979. In fall 1996, the water was 2 feet above the floor. Most at risk were the lower parking lot and the 2 vehicle repair bays in the building used by the town's police and fire departments. The project submitted in December 1996 received approval from the Massachusetts Emergency Management Agency and the Massachusetts Department of Environmental Management, the agencies that jointly administer the commonwealth's hazard mitigation plan. The Federal Emergency Management Agency Hazard Mitigation Grant Program provided $217,326 of the total project cost of $289,768.

A concrete floodwall and stormwater pumping station were installed at the Public Safety Building. Culvert upgrades were made at Lindor Road and Elm Street.
Green International Affiliates, Inc. did the field survey, hydrologic and hydraulic analyses, civil engineering design, environmental permitting, cost estimating, bid assistance, grant coordination, and construction contract administration assistance.

A new flood wall protects North Reading's Public Safety Building

Interagency Committee Responsibilities

Over the past 10 years, the Interagency Hazard Mitigation Committee's responsibilities have evolved into the following:

1) Review and update the State Hazard Mitigation Plan as required by the Disaster Mitigation Act of 2000 and 44 CFR, Subpart M. These activities may include:
   a. Review, update and prioritize recommendations in the State Hazard Mitigation plan.
   b. Develop a comprehensive strategy for the development and implementation of the State's mitigation program.
   c. Establish policies consistent with the statewide mitigation goals in the State Hazard Mitigation Plan.

2) Review applications for hazard mitigation grants, especially under the Hazard Mitigation Grant Program (HMGP), the Flood Mitigation Assistance (FMA) program, and the new Pre-Disaster Mitigation Program.

3) Identify additional federal, state and local funding sources for mitigation projects.

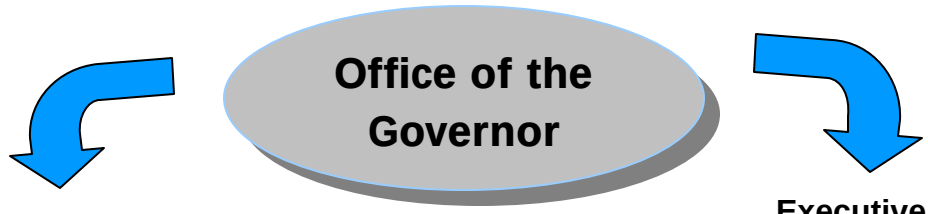
4) Act as "subject matter experts" for ongoing hazard mitigation projects from initiation to close-out.

5) Serve as the federal Interagency Hazard Mitigation Committee following a Presidential disaster declaration following a large-scale disaster.

6) Meet on a minimum of once a year during non-disaster years and meet on an as-needed basis following a Presidential disaster declaration.

The following chart is an overview of the organization and coordination of the Massachusetts Interagency Hazard Mitigation Committee, which includes state, federal and private partners since 1992:

MA Hazard Mitigation Planning Process & Program Coordination



Executive Office of Environmental Affairs

Department of Conservation & Recreation (formerly the Department of Environmental Management)

State Hazard Mitigation Officer

Executive Office of Public Safety/Office of Emergency Services

Massachusetts Emergency Management Agency

Governor's Authorized Representative

State Hazard Mitigation Team

(Full time staff)

- DCR/State Hazard Mitigation Officer
- MEMA/Disaster Recovery Manager
- MEMA/DCR Hazard Mitigation Planning Coordinator
- National Flood Insurance Program Coordinator
- MEMA Grants Coordinator
- DCR Flood Hazard Management Technical Staff (2)

State Interagency Mitigation Committee

- Board of Building Regulations & Standards (BBRS)
- Coastal Zone Management (CZM)
- DCR Water Supply Protection
- DCR Waterways
- DCR Office of Dam Safety
- DFW Riverways
- DEP Wetlands and Waterways
- Housing & Community Development
- Woods Hole Oceanographic Institute
- Cape Cod Cooperative Extension
- National Fire Protection Association (NFPA)
- New England Disaster Recovery Information X-Change (NEDRIX – an association of private companies & industries involved in disaster recovery planning)
- MA Board of Library Commissioners
- MA Highway Dept.
- MA Division of Marine Fisheries
- MA Division of Capital & Asset Management (DCAM)
- Massachusetts Association of Regional Planning Agencies (MARPA)
- University of Massachusetts/Amherst
- Natural Resources Conservation Services (NRCS)
- MA Historical Commission
- U.S. Army Corps of Engineers
- Federal Emergency Management Agency

3.4 Planning Process for the State Mitigation Plan

This section describes the planning process used by the state in order to develop this State Hazard Mitigation Plan per the requirements of the Disaster Mitigation Act of 2000:

1. Massachusetts has used the one time only 2002 PDM planning grant of $50,000 to fund a statewide natural hazards risk assessment and GIS hazard maps project which was contracted to Dewberry in 2002. The final report by Dewberry and corresponding maps are found throughout Section 4 and Appendices E, F, and G.

2. The State Hazard Mitigation Team presented Dewberry's scope of work for the risk and vulnerability assessment to the State Interagency Hazard Mitigation Committee in December 2002, prior to the start of the analysis. The scope was developed to meet the state mitigation planning requirements per the DMA 2000.

3. The State Hazard Mitigation Officer and State Planning Coordinator met continuously with Dewberry throughout 2003 and early 2004 to gather the best available data for the risk and vulnerability assessment (see Appendix G for the final report by Dewberry).

4. The state provided final copies of risk and vulnerability assessment report and GIS maps to the six funded RPAs and the State Interagency Committee in early 2004 for comment.

5. The State Hazard Mitigation Plan has been made available by a posting of the first draft on MEMA's website in May 2004 for input from communities, participating regional planning agencies and local government officials currently participating in the mitigation planning process, as well as from the general public.

6. A State Interagency Hazard Mitigation Committee meeting was held in June 2004 for additional input on the plan and to outline the ongoing state mitigation planning process. Received additional input from several committee members for the second and final drafts.

7. A second draft of the State Mitigation Plan was posted to MEMA's website in Sept. 2004 for additional public comment, especially from the emergency management community, RPAs and the general public.

8. The State Mitigation Plan has been reviewed by the State Interagency Hazard Mitigation Committee which consists of the State Mitigation Team of DCR and MEMA full-time staff members as well as several state and federal government agencies and private sector representatives.

9. The State Mitigation Plan has been approved by the Director of MEMA and the Commissioner of DCR.

MA Mitigation Success Story:

Rising Above Flood Waters in Tewksbury

The April Fool's Day Rain Storm of 2004 was no joke to thousands of Massachusetts residents who had to put up with the effects of yet another rain induced flood event that resulted in a Presidential disaster declaration. The two-day storm dropped over 7 inches of rain in many cities and towns north and west of Boston, with Belmont, Winchester, Peabody, Gloucester and Tewksbury having some of the biggest rainfall amounts. Many residents would agree that April 2004 was a wet month; in fact the wettest month since June 1998, when storms dropped over 11" of rain in the Boston area to warrant yet another Presidential Disaster declaration.

Although a lot of focus is correctly put on the victims of the latest flooding, it's important to point out that the storm could have caused a lot more damage to many more properties and disrupted many more lives. The rising waters of the Shawsheen River frequently attract spectators to Karen McCarthy's neighborhood and then isolate residents as roads are closed. After repeated flood damage to her Tewksbury home in the years leading up to 2001, she was ready when the town applied for a FMA grant to elevate her building. During three previous disasters, over $30,000 in losses had occurred to the property.

When work started in July 2002, she and her husband didn't know exactly what would be involved. The work disclosed previously unknown decay to the house's sills and joists due to eighty years of periodic immersion. The repairs and building elevation took three months and more money then was originally set aside. Both the FEMA Region I office and the Massachusetts Emergency Management Agency's Disaster Recovery Program saw the project through by obtaining additional federal funds.

When the swiftly flowing river again crested on April 2, 2004, Mrs. McCarthy's family was high and dry within their home. A few outdoor items floated in the yard as a Boston television crew interviewed her spouse. Eight inches of rain had fallen and another federal disaster had been declared throughout their area. Karen McCarthy later commented about the elevation project, "Make sure you know what you are getting into. We didn't, but in the end it was well worth it". She is happy they have been able to stay in their neighborhood and still avoid flood losses.

(Source: Excerpts from the May 2004 newsletter, Success: Reducing Flood Damages in Massachusetts, prepared by the Federal Emergency Management Agency Disaster Field Office, FEMA 1515-DR-MA.)

4. State Risk Assessment

4.1 Identifying Natural Hazards

Between 1980 and 2002, the U.S. endured 54 weather-related disasters in which overall damages and costs reached or exceeded $1 billion per event. Of these disasters from natural hazards, 45 occurred during the 1988-2002 period with total damage and related costs of nearly $200 billion for that period.[i]

A natural hazard is defined as "an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, and agricultural loss, damage to the environment, interruption of business, or other types of harm or loss."[ii] A natural hazard can also be exacerbated by societal behavior and practice, such as building in a floodplain, along a sea cliff or an earthquake fault. Natural disasters are inevitable, but the impacts of natural hazards can, at a minimum, be mitigated or, in some instances, prevented entirely.

In order to fulfill the planning guidelines outlined in the Disaster Mitigation Act of 2000, this State Hazard Mitigation Plan focuses on the risk assessment, analysis and recommendations for natural hazards mitigation only and not the man-made hazards (i.e. structural fires, hazardous materials). Sections of this plan, such as critical infrastructure maps, may be utilized to develop other long-term mitigation strategies for man-made hazards, such as counter terrorism.

For the 2004 Update of the Massachusetts State Hazard Mitigation Plan's risk assessment, natural hazards have been grouped in the following categories and are listed in order of frequency, starting at the top of the list with the most frequent natural hazards:

#1 Flood-related hazards

#2 Wind-related hazards

#3 Winter-related hazards

#4 Fire-related hazards (drought)

#5 Geologic-related hazards

#6 Other potential hazards

This grouping is based on data collected for Massachusetts' State Hazard Mitigation, or 409, Plan, previously approved by FEMA in 1998 and 2000 as well as additional information gathered by The Dewberry Companies as part of this update of the State Hazard Mitigation Plan. During October of 2002, the Commonwealth retained a consultant with a background in natural hazards mitigation, The Dewberry Companies, to provide assistance with updating the Vulnerability and Risk Assessment portion this plan. This updated vulnerability and risk assessment, which includes recent GIS maps and analysis performed by Dewberry, as well as a history of the natural hazards which have impacted Massachusetts, is included throughout the following section.

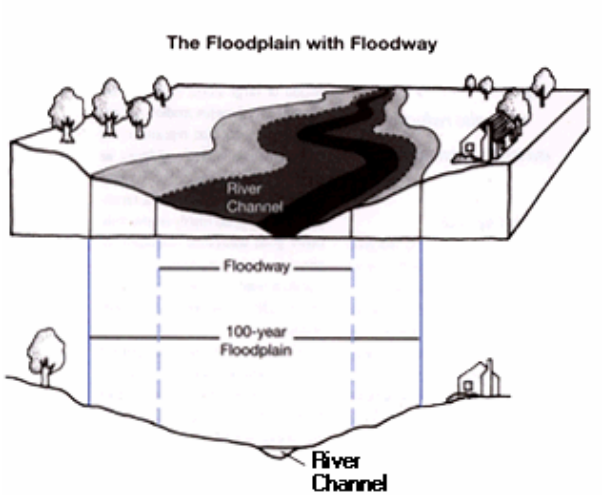
#1 Flood-Related Hazards

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss – 75% of federal disaster declarations are related to flooding. Property damage from flooding totals over $5 billion in the United States each year.[iii] The following section includes brief descriptions of the various types of flood-related hazards most likely to affect Massachusetts.

Types of Flooding A flood, which can be slow, or fast rising but generally develop over a period of days, is defined by the National Flood Insurance Program is: "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from:

- Overflow of inland or tidal waters,
- Unusual and rapid accumulation or runoff of surface waters from any source, or
- A mudflow.

[The] collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood." [iv]



What is a Floodplain? By their very nature, floodplains are the low, flat, periodically flooded lands adjacent to rivers, lakes and oceans and subject to geomorphic (land-shaping) and hydrologic (water flow) processes. As distinguished from the floodplain, a river's floodway is the dry zone which conveys flood waters. It is only during and after major flood events that the connections between a river, its floodway and its floodplain become more apparent. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. In addition, the floodplain represents a natural filtering system, with water percolating back into the ground and replenishing groundwater. When a river is divorced from its floodplain with levees and other flood control facilities, then natural, built-in benefits are either lost, altered, or significantly reduced.[v]

The 100 Year Flood The term "100-year flood" is misleading. It is not the flood that will occur once every 100 years. Rather, it is the flood that has a 1- percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most Federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management and to determine the need for flood insurance. A structure located within a Special Flood Hazard Area (SFHA) shown on an NFIP map has a 26 percent chance of suffering flood damage during the term of a 30-year mortgage.

Flooding in Massachusetts Flooding is often the direct result of other frequent weather events in Massachusetts such as coastal storms, also known as “nor’easters,” heavy rainstorms, tropical storms and hurricanes. As a result of these events Massachusetts is susceptible to:

- **Riverine, or inland, flooding**, including overflow from river channels, flash floods, ice-jams and dam-breaks as well as a result of tropical storms or hurricanes (see following section on hurricanes for a more detailed description).

- **Coastal flooding**, as the result of storm surges and coastal erosion, (storm surges also contribute to coastal erosion) which in turn contributes to shoreline change. Massachusetts is exposed to coastal flooding along its 1,500 miles of coastline shoreline, encompassing 78 communities. (More details on these communities and maps may be found in Section 4.3)

- **Basement and roadway flooding, or stormwater flooding,** due to poor or insufficient storm water drainage, high groundwater levels and high percentage of impervious surfaces which prevents groundwater recharge.

Coastal Storms - A northeast coastal storm, known as a northeaster, is typically a large counter-clockwise wind circulation around a low pressure center. The storm radius is often as much as 1000 miles, and the horizontal storm speed is about 25 miles per hour, traveling up the eastern United States coast. Sustained wind speeds of 10-40 mph are common during a northeaster with short term wind speeds gusting up to 70 mph. Storm information is available on weather charts published by the National Weather Service.[vi] Northeasters are a common winter occurrence in New England and repeatedly result in flooding, various degrees of wave and erosion-induced damage to structures, and erosion of natural resources, such as beaches, dunes and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms.

This type of storm is a primary concern for Massachusetts' residents not only because of the damage potential in any given storm, but because there is a frequent rate of recurrence. Northeasters have an average frequency of 1 or 2 per year with a storm surge equal to or greater than 2.0 feet. The comparison of hurricanes to northeasters reveals that the duration of high surge and winds in a hurricane is 6 to 12 hours while a northeaster's duration can be from 12 hours to 3 days.

Figure 7-34
A breach was cut across Nauset Spit on Cape Cod, Massachusetts, by a January 1987 northeaster. The breach grew from an initial width of approximately 20 feet to over a mile within 2 years, exposing the previously sheltered shoreline of Chatham to ocean waves and erosion. Photograph by Jim O'Connell.

Source: FEMA's Coastal Construction Manual, Third Edition

Figure 7-35
1988 photograph of undermined house at Chatham, Massachusetts. Nine houses were lost as a result of the formation of the new tidal inlet shown in Figure 7-34. Photograph by Jim O'Connell.

Source: FEMA's Coastal Construction Manual, Third Edition

The last three Presidential declarations in Massachusetts, April

2004, December 2003, and February 2003, were the result of winter northeasters. In October 1996, a large coastal storm event caused more than $90 million in flood damage in the greater Boston area and suburbs throughout eastern Massachusetts. This resulted in a Presidential declared disaster (FEMA-1142-DR-MA) for Middlesex, Essex, Norfolk, Plymouth and Suffolk counties. During this event, the Massachusetts Bay Transportation Authority (MBTA) alone incurred more than $50 million in damages. This was the worst flooding in eastern Massachusetts since the spring of 1987 when a pair of severe rainstorms within roughly a one-week time period produced extremely damaging flooding. The 1987 event also resulted in a Presidential declaration (FEMA-790-DR-MA) for Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk and Worcester counties. Damages from the storms of March 30 to April 8, 1987 were estimated at over $40 million in Massachusetts.

The level of damage in a strong hurricane is often more severe than a northeast storm but historically, Massachusetts has suffered more damage from northeasters because of the greater frequency of these coastal storms (1 or 2 per year).

Coastal Erosion & Shoreline Change Coastal shorelines change constantly in response to wind, waves, tides, sea level fluctuation, seasonal and climatic variations, human alteration and other factors that influence the movement of sand and material within a shoreline system. The loss (erosion) and gain (accretion) of coastal land is a visible result of the way shorelines are reshaped in the face of these dynamic conditions. Shorelines tend to change seasonally, accreting slowly during the summer months when sediments are deposited by relatively low energy waves and eroding dramatically during the winter when sediments are moved offshore by high energy storm waves, such as those generated by northeasters. [vii] Regardless of the season, coastal storms typically cause erosion and with the anticipated change in climate, evidenced in part by the ongoing global warming phenomenon, the increase in intensity and frequency of storms is expected. This will in turn increase the likelihood of severe erosion episodes along the coast of Massachusetts.

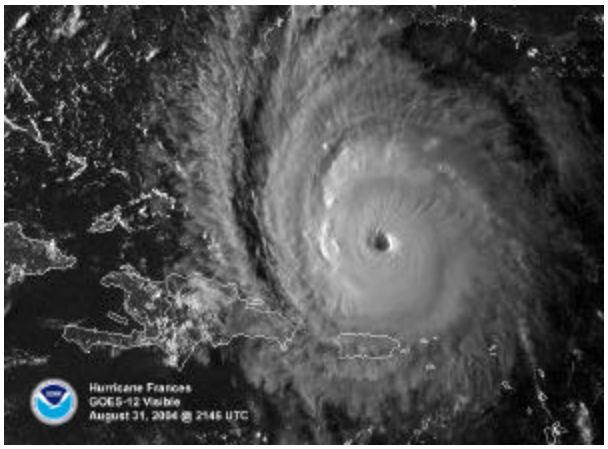
Massachusetts has approximately 1,500 miles of coastal shoreline encompassing 78 communities. In addition, Massachusetts shoreline has an extremely varied geographic orientation with diverse geologic landforms of varying elevations. These variables make coastal pre-storm disaster planning, response coordination, post-storm recovery activities and hazard mitigation exceptionally challenging. Add to this mix a heavily developed area - approximately 75% of Massachusetts' development has historically occurred within its coastal zone, according to the Massachusetts Coastal Zone Management. This increased development makes the storm-induced surge, waves, flooding and erosion associated with northeasters a primary concern in of the state's coastal floodplain and hazards management agencies. [viii]

Coastal erosion and shoreline change, while usually not an imminent threat to public safety in general, can result in significant economic and emotional loss in a system of fixed property lines and ownership and can destroy buildings, roads, infrastructure, natural resources and wildlife habitats Damage often results from the combination of an episodic event with severe storm waves and dune or bluff erosion. For instance, in the early 1990s, four large events had a major impact on the Massachusetts' coastline – Hurricane Bob, the

October 1991 Northeaster, the December 1992 Northeaster and the March 1993 storm – as well as the most recent coastal storms in the winters of 2001 and 2003, and spring 2004.

Some of the methods used by property owners to stop, or slow down, coastal erosion or shoreline change can actually exacerbate the problem. Attempting to halt the natural process of erosion with seawalls and other hard structures, typically worsens the erosion in front of the structure, prevents any sediment behind the structure from supplying down drift properties with sediment and subjecting down drift property owners to similar losses. This forces these property owners to consider hard structures to prevent erosion in front of their property and thereby perpetuating the problem down drift. Also, without the sediment transport associated with erosion, some of the Commonwealth's greatest assets and attractions – beaches, dunes, barrier beaches, salt marshes, and estuaries – are threatened and will slowly disappear as the sand sources that feed and sustain them are eliminated. [ix]

The Massachusetts Coastal Zone Management (CZM) Office has been studying and monitoring shoreline change as well as collecting new data. Additional information on shoreline change may be found in the next section, Section 4: Assessing Vulnerability as well as in CZM's Fact Sheet on New Data on Shoreline Change in Appendix H or online at http://www.mass.gov/czm/shorelinechange.htm



Hurricanes & Tropical Storms – Both hurricanes and tropical storms can produce substantial damage from storm surge, waves, erosion and intense winds. While storm surge has been the number one cause of hurricane related deaths in the past, more people have died from inland flooding associated with tropical systems in the last 30 years. Since the 1970s, inland flooding has been responsible for more than half of all deaths associated with tropical cyclones in the United States. Inland flooding from hurricanes can occur hundreds of miles from the coast placing communities, which would not normally be affected by the strongest hurricane winds, in great danger (see previous section on flooding).

Some of the greatest rainfall amounts associated with tropical systems occurs from weaker tropical storms that have a slow forward speed (1 to 10mph) or stall over an area. Due to the amount of rainfall a Tropical Storm can produce, they are capable of causing as much damage as a category 2 hurricane. For a more detailed description of hurricanes and tropical storms, see the following section on Wind-Related Hazards.

Heavy Rainstorms & Thunderstorms - Massachusetts is regularly susceptible to flooding from severe rainstorms and thunderstorms throughout the warmer months. There so many frequent rainstorms and thunderstorms that a potential GIS maps designed to show the number of severe storms was impossible to read – the entire state was completely covered with rainstorm events to the point where every community appeared to be equally susceptible to rainstorm events . The decision was made to note and track only the heaviest rainstorms causing major property damage.

An example is the flooding following heavy rainstorms in June 1998 and October 1996. On June 12 through June 14, 1998 a very slow moving and complex storm system moved through southeast New England. The combination of its slow movement and presence of tropical moisture across the region produced rainfall of 6 to 12 inches over much of eastern Massachusetts. This led to widespread urban, small stream and river flooding. As a result, the counties of Suffolk, Essex, Middlesex, Norfolk and Bristol received a Presidential Disaster Declaration for Individual Assistance on June 23, 1998. The counties of Plymouth and Worcester were added to the initial declaration on July 3, 1998. The June 1998 storm, which caused more than $7 million in personal property damage (FEMA-1224-DR-MA), mirrored, to a lesser degree, the more severe October 1996 event.

Dam Breaches There are over 2,900 public and privately-owned dams across Massachusetts. As Massachusetts infrastructure ages while maintenance and inspection costs increase during current state and municipal budget restraints, there is good reason to believe that there may be an increased risk for a dam breach in more populated areas.

Under Section 2 of Chapter 330 of the Acts of 2002, passed by the Massachusetts legislature, also known as "An Act Relative to the Inspection, Registration, Constructions, and Reconstruction of Dams," the definition of a "dam" in Massachusetts is:

> *…any artificial barrier, including appurtenant works, which impounds or diverts water, and which (1) is 25 feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier, or from the lowest elevation of the outside limit of the barrier, if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of 50 acre feet or more. Any other artificial barrier, including appurtenant works, the breaching of which could endanger property or safety, may be designated by the commissioner as a dam, and shall be subject to sections 44 to 50, inclusive.*
>
> *The word "dam" shall not mean any of the following: (1) any appurtenant works which temporarily impounds or diverts water used on land in agricultural use as defined pursuant to section 131 of chapter 40, (2) any barrier or appurtenant works which has a size classification of small or low hazard potential classification that is used on land in agricultural use as defined in said section 131 of said chapter 40, and (3) any barrier which is not in excess of 6 feet in height, regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of 15 acre feet, regardless of height. The commissioner shall make such determination by taking into consideration factors such as height, type of structure, condition of structure, volume of the impoundment, extent of development downstream, and other factors deemed appropriate by the commissioner.*

In addition, under ***302 CMR 10.00: Dam Safety***, the size of a dam, hazard classification and inspection schedules are defined as follows:

10.06: Dam Size and Hazard Classification

(1) General. Dams shall be classified for purposes of establishing inspection schedules and adherence to design criteria, in accordance with their potential for damage to life or property in the area downstream from the dam in the event of failure or mis-operation of the dam or appurtenant facilities. This determination shall be made by the Commissioner and noted on the owner's Certificate of Registration. It may be necessary to periodically reclassify dams as additional information becomes available and/or conditions change. The following criteria shall be used by the Commissioner to determine the size and hazard potential classification

based upon the extent of development downstream from the dam, taking into consideration factors such as height, type of structure and volume of impoundment, pursuant to M.G.L. c. 253, § 44.

(2) Size Classification. The classification for size based on the height of the dam and storage capacity shall be in accordance with the following table. The height of the dam is established as defined herein; with respect to maximum water storage elevation. The storage capacity of the dam is the volume of water contained in the impoundment at maximum water storage elevation measured as defined herein. Size class may be determined by either storage or height, whichever gives the larger size classification.

SIZE CLASSIFICATION TABLE

Category	Storage (acre-feet)	Height (feet)
Small	>= 15 and <50	>= 6 and <15
Intermediate	>= 50 and <1000	>= 15 and <40
Large	>= 1000	>= 40

(**3) Hazard Potential Classification**. The classification for potential hazard shall be in accordance with table below. The hazards pertain to potential loss of human life or property damage in the event of failure or improper operation of the dam or appurtenant works. Probable future development of the area downstream from the dam that would be affected by its failure shall be considered in determining the classification. Dams will be subject to reclassification if the Commissioner determines the hazard has changed.

HAZARD POTENTIAL CLASSIFICATION TABLE

Classification	Hazard Potential
High Hazard (Class I):	Dams located where failure or mis-operation will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).
Significant Hazard (Class II):	Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.
Low Hazard (Class III):	Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

(4) Dams in Series.

(a) If an upstream dam has the capability to create failure in a downstream dam because of its failure flood wave, it shall have the same or higher hazard classification as the downstream dam. If the failure flood wave of the upstream dam will not cause failure of the downstream dam, the upstream dam may have a different hazard potential classification from the downstream dam.

(b) The classification of each dam shall be reviewed during each subsequent periodic inspection.
(c) Potential damage to habitable structures will be considered minor when habitable structures are not within the direct path of the probable flood wave produced upon failure of a dam or where such structures will experience:
1. No more than 2.0 feet incremental rise of flood water above the lowest ground elevation adjacent to the outside foundation walls; or
2. No more than 2.0 feet incremental rise of flood water above the lowest habitable floor elevation of the structure; the lower of the two elevations governing.

(5) Failure Damage. The extent of potential damage resulting from a dam breach may justify designating damage as either major or minor. Such a designation may be made after a detailed analysis has established the relative impact of the probable dam breach and has considered the following factors:

(a) the conditions prior to and after a dam breach;
(b) the extent to which access has been affected, both before and after a dam breach; and
(c) the extent of damage.

(6) Hazard Reconsideration. An Owner may at any time request the Commissioner to reconsider his hazard determination. The Owner's request must be filed by registered professional civil engineer, specifying the findings and analyses with which the Owner disagrees.

10.07: Inspection Schedule

(1) The Commissioner or his designee may enter upon private property at any time to investigate or inspect any dam.
(2) The Commissioner shall periodically inspect all dams in accordance with the following schedule. These time periods are the maximum time between inspections, more frequent inspections may be performed at the discretion of the Commissioner.

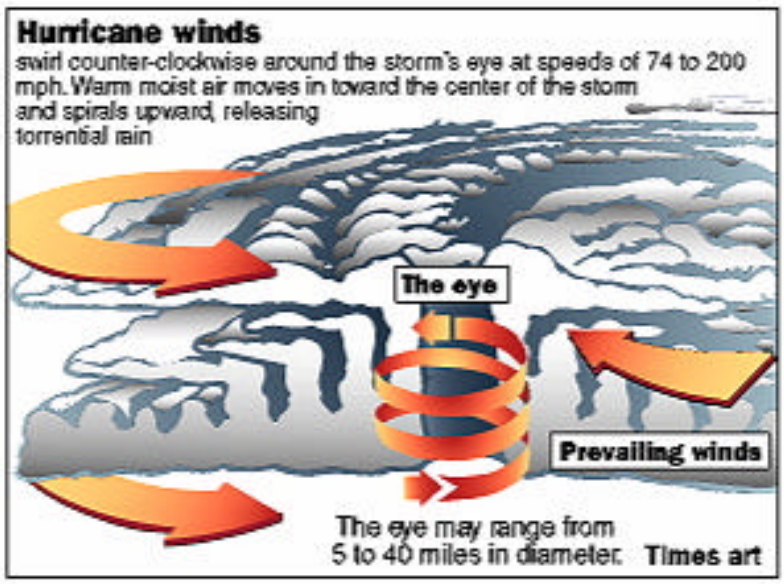
DAM INSPECTION FREQUENCY

Hazard Potential	Size Classification	Inspection Frequency
Low	small intermediate large	10 years 10 years 10 years
Significant	small intermediate large	5 years 5 years 5 years
High	small intermediate large	2 years 2 years 2 years

Additional information on the location of the high and significant hazard dams can be found in the following section on Vulnerability by Jurisdiction.

#2 Wind-Related Hazards

Hurricanes According to the National Hurricane Center, a hurricane or a tropical storm are technically different types of tropical cyclones. The Center defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center." [x]



Massachusetts is susceptible to hurricanes and tropical storms. Between 1858 and 2000, Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricanes. To date, the Commonwealth has not experienced a Category 4 or 5 hurricane. A complete map of these hurricane tracks may be found in Appendix F.

The last hurricane to reach landfall in New England was Hurricane Bob, a weak category 2 hurricane, in August 1991. Unfortunately, Massachusetts, and the rest of New England, is long overdue for another major hurricane strike. Based on past hurricane and tropical storm landfalls, the frequency of hurricanes to hit the Massachusetts coastline is an average of once out of every six years. Since the destructive hurricane of 1938, four other major hurricanes have struck the Massachusetts coast in 1954, 1955, 1985, and 1991.

For the exact locations and wind zones for hurricanes and tropical storms, see the map of past hurricane and tropical storm strikes in the section on "Assessing Vulnerability by Jurisdiction."

How Are Hurricanes Formed? Hurricanes begin as tropical storms over the warm moist waters of the Atlantic and Pacific Oceans near the equator. (Near the Philippines and the China Sea, hurricanes are called typhoons.) As the moisture evaporates, it rises until enormous amounts of heated moist air are twisted high in the atmosphere. The winds begin to circle counterclockwise north of the equator or clockwise south of the equator. The relatively peaceful center of the hurricane is called the eye.

Around this center winds move at speeds between 74 and 200 miles per hour. As long as the hurricane remains over waters of 79° F or warmer, it continues to pull moisture from the surface and grow in size and force. When a hurricane crosses land or cooler waters, it loses its source of power and its wind gradually slow until they are no longer of hurricane force--less than 74 miles per hour. At this point, the hurricane becomes a tropical storm in which the maximum sustained surface wind speed ranges from 39 mph to 73 mph.

Hurricanes over the Atlantic often begin near Africa, drift west on the Trade Winds, and veer north as they meet the prevailing winds coming eastward across North America. Hurricanes over the Eastern Pacific begin

in the warm waters off the Central American and Mexican coasts. Eastern and Central Pacific storms are called "hurricanes." Storms to the west of the International Date Line are called "typhoons." [xi]

The hurricane season in the Atlantic, Caribbean, and Gulf of Mexico runs from June 1 to November 30. The hurricane season in the Eastern Pacific basin runs from May 15 to November 30. The hurricane season in the Central Pacific basin runs from June 1 to November 30.

A **hurricane warning** is issued by the National Weather Service when sustained winds 74 mph or 119 km/hr or higher associated with a hurricane are expected in a specified coastal area in 24 hours or less. A hurricane warning can remain in effect when dangerously high water or a combination of dangerously high water and exceptionally high waves continue, even though winds may be less than hurricane force. A **hurricane watch** is announced for specific coastal areas that hurricane conditions are possible within 36 hours.

The following Saffir/Simpson Scale e gives an overview of the wind speeds and range of damage caused by different hurricane categories:

SAFFIR/SIMPSON HURRICANE SCALE

Scale No. (Category)	*Winds (mph)*	*Storm Surge (ft)*	*Potential Damage*
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	18	Catastrophic

For more up-to-date information on hurricanes and the history of hurricanes in New England, go to the website of the National Hurricane Center at www.nhc.noaa.gov , or to Appendix H for more information specific Massachusetts hurricanes and tropical storms.

Tornadoes Although tornadoes occur throughout the world, they are most intense and devastating in the United States where approximately 1000 tornadoes are recorded every year. Today, only a few are killers, but that has not always been so. About 200 US tornadoes have killed 18 or more people. Of those, about 150 occurred in the 70 year period between 1879 and 1949. There have been about 45 tornadoes since 1950 that have killed 18 or more people. In the 1950s, there were 18 tornadoes that killed 18 or more people. In the 1960s, there were 12 tornadoes that killed 18 or more people. In the 1970s, there were 11 tornadoes that killed 18 or more people. And in the 1980s, there were only 2 tornadoes that killed more than 18 people. In spite of an ever-burgeoning population, death figures continue to go down as improved forecasting, detection, communications, and public awareness increase. [xii]

Tornadoes can strike at any time of day, but are much more frequent in the afternoon and evening, after the heat of the day has produced the hot air that powers a "tornadic thunderstorm" -- a thunderstorm-storm that produces a tornado. Although tornados occur most often in the central United States, tornados can and do happen any time of the year in just about any location.

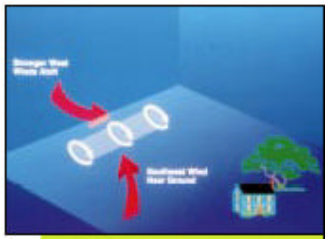
A tornado is a rapidly rotating vortex or funnel of air extending ground ward from a cumulonimbus cloud. Most of the time, vortices remain suspended in the atmosphere. When the lower tip of a vortex touches earth, the tornado becomes a force of destruction. Tornadoes occur during a single atmospheric condition, such as a thunderstorm, and multiple tornadoes can be generated by a hurricane or a combination of several thunderstorms

Tornadoes are most likely to occur between 3 and 9 p.m. but have been known to occur at all hours of the day or night. The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction. The average forward speed is 30 mph but may vary from nearly stationary to 70 mph. [xiii] Tornadoes occasionally accompany tropical storms and hurricanes that move over land. Tornadoes are most common to the right and ahead of the path of the storm center as it comes onshore.

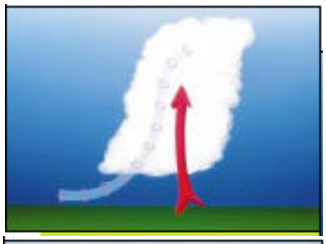
Waterspouts - Waterspouts are weak tornadoes that form over warm water and are most common along the Gulf Coast and southeastern states, but they have occurred along the Massachusetts coastline. Since 1995, six waterspouts have been observed in Massachusetts with the most recent seen in Rockport, MA in May 2000. Waterspouts occasionally move inland becoming tornadoes causing damage and injuries. In the western United States, they occur with cold late fall or late winter storms, during a time when you least expect tornado development. In the northeast, it appears that waterspouts, like tornadoes, may occur at any time with the "right" climatic conditions (see following chart).

How Tornadoes & Waterspouts Form

1. Before thunderstorms develop, a change in wind direction and an increase in wind speed with increasing height create an invisible, horizontal spinning effect in the lower atmosphere.



2. Rising air within the thunderstorm updraft tilts the rotating air from horizontal to vertical.



3. An area of rotation, 2-6 miles wide, now extends through much of the storm. Most strong and violent tornadoes form within this area of strong rotation.

(*Source: National Severe Storm Laboratory website, http://www.nssl.noaa.gov/NWSTornado*)

The Fujita Tornado Scale Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. Tornado width is estimated by the path of destruction -- which can be up to one mile wide. This scale assigns numerical values based on wind speeds and categorizes tornadoes from 0 to 5. The letter "F" often precedes the numerical values. Scale values above F5 are not used because wind speeds above 318 mph are unlikely. The following table lists the scales, wind speeds and average occurrence rates within the United States:

Fujita Tornado Scale

	Scale No. (Category)	*Winds (mph)*	*Frequency (annual average)*	*Potential Damage*
	F0	40 – 72	218 or 29%	**Light damage** - Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
	**F1**	73 – 112	175 or 23%	**Moderate damage** - Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off road.
	**F2**	113 – 157	301 or 40%	**Considerable damage** - Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
	**F3**	158 – 206	43 or 6 %	**Severe damage** - Roofs and some walls torn off well-constructed houses, trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.
	**F4**	207 - 260	10 or 1 %	**Devastating damage** - Well-constructed houses leveled; structure with weak foundations blown off some distance; cars thrown and large missiles generated.
	**F5**	261-318	1 or .002%	**Incredible damage** - Strong frame houses lifted off foundations and swept away; automobile sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.
	F6	319 – 379	?	**Inconceivable Damage –** If this is ever achieved, evidence for it might only be found is some manner of ground swirl pattern, for it may never be identifiable through engineering studies.

***IMPORTANT NOTE ABOUT F-SCALE WINDS*:** F-scale winds should not be taken literally. These wind speed numbers are estimates and have never been scientifically verified. Different wind speeds may cause similar-looking damage from place to place—even from building to building. Without a thorough engineering analysis of tornado damage in any event, the actual wind speeds needed to cause that damage are unknown. *(Source: NCDC/NOAA, website, http://www.noaa.gov/tornadoes.html, Feb. 2004)*

The Worcester Tornado

The most destructive tornado in New England history was the Worcester tornado of June 9, 1953. The F4 tornado hit at about 3:30 p.m. The funnel quickly intensified, carving a 46-mile path of death and destruction as it moved through eight communities. The twister tore through Barre, Rutland, Holden, Worcester, Shrewsbury, Westborough, Southborough and Fayville, Mass. It killed 94 people and left almost 1,300 people injured. The National Storm Prediction Center ranks it as the 20th deadliest tornado in the nation's history.
With wind speeds between 200 to 260 mph, the force of the tornado carried debris miles away and into the Atlantic Ocean. A music box and a 3-foot aluminum trap door were found about 35 miles away, according to the National Oceanic and Atmospheric Administration.

The remains of Assumption College following the Worcester Tornado of 1953

Based of the type of complete destruction, it was believed that this tornado was an F5 – the most severe on the Fujita Tornado Scale. Two other deadly tornadoes occurred later – the May 29, 1995 Great Barrington tornado, an F4, which claimed 3 lives and injured 24, and the August 28, 1973 West Stockbridge tornado, a F4, which killed 4 and injured 36.

Damage in Worcester following the 1953 tornado.

Photographs of damage from the Worcester tornado of 1953, taken by Alfred K. Schroeder, courtesy of the Massachusetts Historical Society

#3 Winter-Related Hazards

Winter weather in Massachusetts and southern New England can be described as unpredictable. Days of frigid, arctic air and below freezing temperatures may be followed by days of mild temperatures in the 40s or 50s. Snowfall and rainfall varies and is often unpredictable, except that Massachusetts residents can count on at least a couple of northeasters which usually bring coastal erosion and could bring either a blizzard or heavy rainstorms dependent, of course, on the temperature.

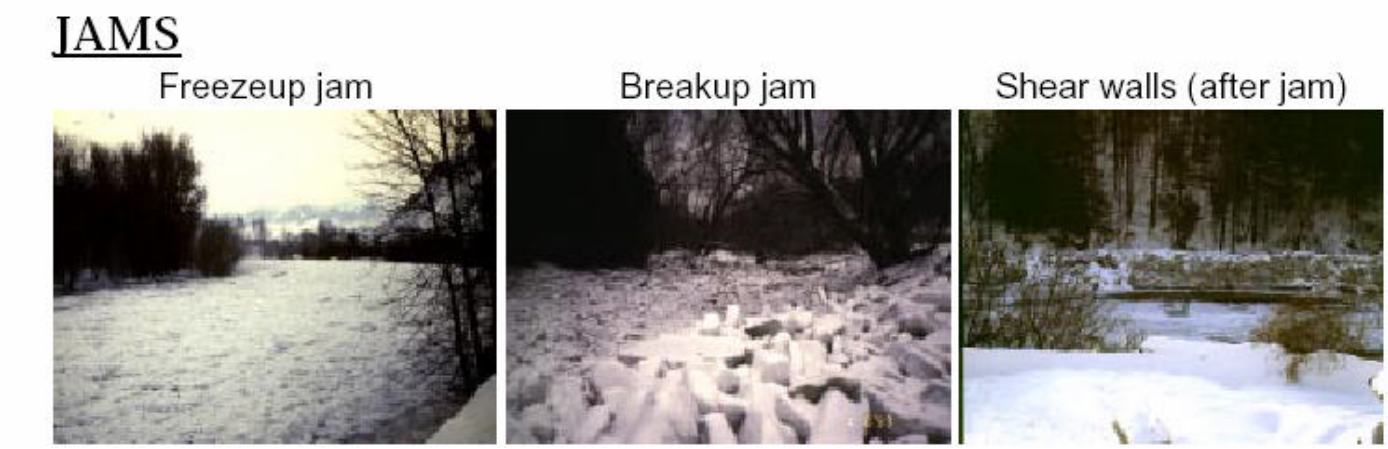
Unless there is an unusual event, such as the Blizzard of 1978, the 1991 No- Name Storm, or 2003 President's Day Storm, which incur an exceptional amount of hardship (i.e. snow and ice removal), threats to public safety and major damage to public and private property, there is no one repository of consistent, detailed descriptions of the types of ongoing, "normal" winter hazards in Massachusetts.

Snow Events - There have been, however, over the past several years, several disaster declarations related to winter weather as well as specific "snow emergency" declarations. These include:

DISASTER NAME (DATE OF EVENT)	**DISASTER NUMBER (TYPE OF ASSISTANCE)**	**DECLARED AREAS**
Blizzard of 1978 (February 1978)	FEMA-546 (Public, Individual)	Counties of Barnstable, Bristol, Dukes, Essex, Nantucket, Norfolk, Plymouth, and Suffolk
December Blizzard (December 1992)	FEMA-975 (Public)	Counties of Barnstable, Dukes, Essex, Plymouth, and Suffolk
March Blizzard (March 1993)	FEMA-3103 (Public)	All 14 Counties
January Blizzard (January 1996)	FEMA-1090 (Public)	All 14 Counties
March Blizzard (March 2001)	FEMA-3165 (Public)	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, and Worcester
February Snowstorm (Feb. 17 – 18, 2003)	FEMA-3175-EM (Public)	All 14 Counties
December Snowstorm (Dec. 5 & 6, 2003)	FEMA 3191-EM (Public)	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester

Ice Jams - Ice jams include those that form in the early winter as ice formation begins (freeze up jams); those which form as a result of the breakup of ice covers (breakup jams); and those which contain elements of both (combination jams).[xiv]

Heavy snowfall and frigid temperatures throughout the Northeast increase the chance of flooding from snowmelt and ice jams. When river ice piles up at shallow areas, bends and islands it blocks the flow of water and may cause flooding of nearby homes and businesses.



Ice jams (breakup jams) occur when warm temperatures and heavy rain cause rapid snow melting. The melting snow combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layer into large chunks, which float downstream and often pile up near narrow passages or near obstructions, such as bridges and dams. Cranes with wrecking balls and explosives are sometimes used to break up ice dams.

Historically, there have been hundreds of ice jams in New England. The most devastating winter floods have been associated with a combination of heavy rainfall, rapid snowmelt, and ice jams. The Ice Jam Database maintained by the US Corps of Army Engineers, Cold Region Research and Engineering Lab, is a searchable database of historic ice jam events. The most recent ice jam and snow conditions may be monitored at the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory website at http://www.crrel.usace.army.mil/ierd/icejam/icejam.htm#intro

Boston residents digging out and coping with the Blizzard of 1978.
(Source: The Boston Globe, February 1978)

#4 Fire-Related Hazards

Fires pose a threat to both urban areas as well as less developed or forested areas. Since the emphasis of this plan is on natural hazards, this section will focus on drought and wildfires. The most recent severe drought conditions in Massachusetts began in 2001 and ended in early 2003. The most recent large, scale wildfire in Massachusetts occurred September 5 - 18, 1995, in the town of Russell.

Drought Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It occurs in virtually all climatic zones yet its characteristics vary significantly from one region to another. Drought is a temporary aberration and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Although it has scores of definitions, it originates from a deficiency of precipitation over an extended period of time, usually two winters or more. This deficiency results in a water shortage for some activity, group, or environmental sector.[xv]

Drought should be considered relative to some long-term average condition of balance between precipitation and evapo-transpiration in a particular area, a condition often perceived as "normal." It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness of the rains (i.e., rainfall intensity, number of rainfall events). Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with it in many regions of the world and can significantly aggravate its severity.

The beginning of a drought is difficult to determine. Several weeks, months, or even years may pass before people know that a drought is occurring. The first evidence of drought usually is seen in rainfall records. Within a short period of time, the amount of moisture in soils can begin to decrease. The effects of a drought on flow in streams and rivers or on water levels in lakes and reservoirs may not be noticed for several weeks or months. Water levels in wells may not reflect a shortage of rainfall for a year or more after a drought begins.

The end of a drought can occur as gradually as it began. Dry periods can last for 10 years or more. During the 1930s, most of the United States was much drier than normal. In California, the drought extended from 1928 to 1937. In Missouri, the drought lasted from 1930 to 1941. That extended dry period produced the "Dust Bowl" of the 1930s when dust storms destroyed crops and farms.

Massachusetts is often considered a “water-rich” state. Under normal conditions, regions across the state annually receive between 40 and 50 inches of precipitation. The precipitation occurs nearly evenly throughout the year. However, Massachusetts can experience extended periods of dry weather, from single season events to multi-year events such as experienced in the mid 1960s. Historically, most droughts in Massachusetts have started with dry winters, rather than a dry summer (*Source: Massachusetts Drought Management Plan, 2002, EOEA & MEMA, page 5).*

During the summer of 2002, one-third of the country, including Massachusetts, experienced drought conditions. The magnitude and complexity of drought hazards have increased in association with growing population, the shift of population to drier regions of the country, urbanization, and changes in land and water use.[xvi] Massachusetts has experienced multi-year drought periods in 1879-83, 1908-12 , 1929-32, 1939-44, 1961-69, and 1980- 83.[xvii] The most severe drought on record in the northeastern United States was during 1961-69. Water supplies and agriculture were affected because of the severity and long duration of the drought. Precipitation was less than average beginning in 1960 in western Massachusetts and beginning in 1962 in eastern Massachusetts.

Drought Levels Identified in the 2002 Massachusetts Drought Management Plan

The Massachusetts Drought Management Plan may be found at www.mass.gov/dem/programs/rainfall/droughtplan.doc

Drought Level	***PDI****	***CMI*****	***Fire*****	***Precipitation***	***Ground Water***	***Streamflow***	***Reservoir***
Normal	-1.0 to –1.99	0.0 to -1.0 slightly dry	Low	1 month below normal	2 consecutive months below normal***	1 month below normal***	Reservoir levels at or near normal for the time of year
Advisory	-2.0 to -2.99	-1.0 to –1.9 abnormally dry	Moderate	2 month cumulative below 65% of normal	3 consecutive months below normal***	At least 2 out of 3 consecutive months below normal***	Small index Reservoirs below normal
Watch	-3.0 to 3.99	-2.0 to –2.9 excessively dry	High	1 of the following criteria met: 3 month cum. < 65% **or** 6 month cum. < 70% **or** 12 month cum. < 70%	4-5 consecutive months below normal***	At least 4 out of 5 consecutive months below normal***	Medium index Reservoirs below normal
Warning	-4.0 and below	< -2.9 severely dry	V. High	1 of the following criteria met: 3 month cum. < 65% **and** 6 month cum. <65% **or** 6 month cum. <65% **and** 12 month cum. <65% **or** 3 month cum. <65% **and** 12 month cum. <65%	6-7 consecutive months below normal***	At least 6 out of 7 consecutive months below normal***	Large index reservoirs below normal
Emergency	-4.0 and below	<-2.9 severely dry	Extreme	Same criteria as Warning **And** Previous month was Warning or Emergency	>8 months below normal***	>7 months below normal***	Continuation of previous month's conditions

* The PDI has been determined to be an inadequate drought indicator, and will be replaced with the Standardized Precipitation Index (SPI) pending future evaluation.

** The Crop Moisture Index and the Fire Danger levels are subject to frequent change. The drought level for these two indicators is determined based on the repeated or extended occurrence of each index at a given level.

*** Below normal for groundwater and streamflow are defined as being within the lowest 25% of the period of record.

Wildfires - Wildfires, or forest and brush fires, have also historically been a problem. There were 3,000 wildfires that burned more than 2,600 acres in Massachusetts during calendar year 2002. In calendar year 2003, nearly 2,000 wildfires burned over 1,600 acres[xviii]. Massachusetts has approximately 350,000 acres of forested wildlands owned by state agencies, with an additional 2,650,000 acres in private ownership.[xix] These forests are potential fuels for wildfires. Particular areas at risk include the Southeastern area of Plymouth County, Cape Cod, and the Islands, where forested areas pose wildland fire and urban interface fire hazards.

The term "wildfire" can be broken into two words. The definition of wild is "something that is not easily restrained; something uncontrollable," while fire is "a destructive burning." The term wildfire then can be defined as "a highly destructive, uncontrollable fire." During a wildfire, the fire produces the same amount of energy in 10 minutes as a nuclear bomb! *(Source: Pacific Disaster Center, www.pdc.org, Feb. 2004)*[xx]

Fires that burn forest plants can be classified in three ways: ground fires, surface fires, and crown fires. Ground fires burn the humus layer of the forest floor, surface fires burn forest undergrowth and surface litter, and crown fires advance through the tops of trees. Atmospheric factors such as temperature, humidity, and rainfall are important factors in determining the combustibility of a given forest.

Humans, either through negligence, accident, or intentional arson, have caused approximately 90% of all wildfires in the last decade. Accidental and negligent acts include unattended campfires, sparks, burning debris, and irresponsibly discarded cigarettes. The remaining 10% of fires are mostly caused by lightning, but may also be caused by other acts-of-nature such as volcanic eruptions or earthquakes.

Wildfires, or wildland fires, are also a natural process, and its suppression is now recognized to have created a larger fire hazard, as live and dead vegetation accumulates in areas where fire has been excluded. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently, federal, state and local agencies are committed to finding ways, such as prescribed burning to reintroduce fire into natural ecosystems, while recognizing that fire fighting and suppression are still important.

In addition, wildfires leave problems behind them, such as debris flows and damage to water supply systems. During an intense wildfire, all vegetation may be destroyed; also the organic material in the soil may be burned away or may decompose into water-repellent substances that prevent water from percolating into the soil. As a result, even normal rainfall may result in unusual erosion or flooding from a burned area; heavy rain can produce destructive debris flows. Water supplies are also affected by wildfires: the loss of ground-surface cover, such as needles and small branches, and the chemical transformation of burned soils make watersheds more susceptible to erosion from rainstorms.

For example, the U.S. Forest Service (USFS) uses greenness maps to generate national maps of selected fire weather and fire danger components of their Wildland Fire Assessment System (http://www.fs.fed.us/land/wfas/welcome.html).

#5 Geologic-Related Hazards

Earthquakes - Although it is well documented that the zone of greatest seismic activity in the United States is along the Pacific Coast in Alaska and California, it may be surprising to most people that an average of 5 earthquakes are felt each year somewhere in New England.[xxi]

New England has had a history of earthquakes including those recorded by the first settlers, and by the Plymouth Pilgrims in 1630. Of the 4738 earthquakes recorded in the Northeast Earthquake Catalog through 1989, 1215 occurred with the boundaries of the six New England States, with 316 earthquakes recorded for Massachusetts between 1627 and 1989. Between 1924 and 1989, there have been 96 earthquakes in the Northeast with a magnitude of 4.5 or greater on the Richter scale. Out of these 96 earthquakes, 8 were within the six New England States and the other 88 within New York State or the Province of Quebec. Many of these earthquakes were so strong that they were felt throughout New England.[xxii] More information on specific locations on earthquakes that have occurred in Massachusetts and New England can be found in the following section, Assessing Vulnerability, on page 90.

How Earthquakes Happen – An earthquake is the vibration, sometimes violent, of the Earth's surface that follows a release of energy in the Earth's crust. This energy can be generated by a sudden dislocation of segments of the crust, by a volcanic eruption, or event by manmade explosions. Most destructive quakes, however, are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and "snap" to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake along the surface and through the Earth at varying speeds depending on the material through which they move. Some of the vibrations are of high enough frequency to be audible, while others are of very low frequency. These vibrations cause the entire planet to quiver or ring like a bell or tuning fork.

A ***fault*** is a fracture in the Earth's crust along which two blocks of the crust have slipped with respect to each other. Faults are divided into three main groups, depending on how they move. ***Normal faults*** occur in response to pulling or tension; the overlying block moves down the dip of the fault plane. ***Thrust (reverse) faults*** occur in response to squeezing or compression; the overlying block moves up the dip of the fault plane. ***Strike-slip (lateral) faults*** occur in response to either type of stress; the blocks move horizontally past one another. Most faulting along spreading zones is normal, along subduction zones is thrust, and along transform faults is strike-slip.

Geologists have found that earthquakes tend to reoccur along faults, which reflect zones of weakness in the Earth's crust. Even if a fault zone has recently experienced an earthquake, however, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In New Madrid, a great earthquake was

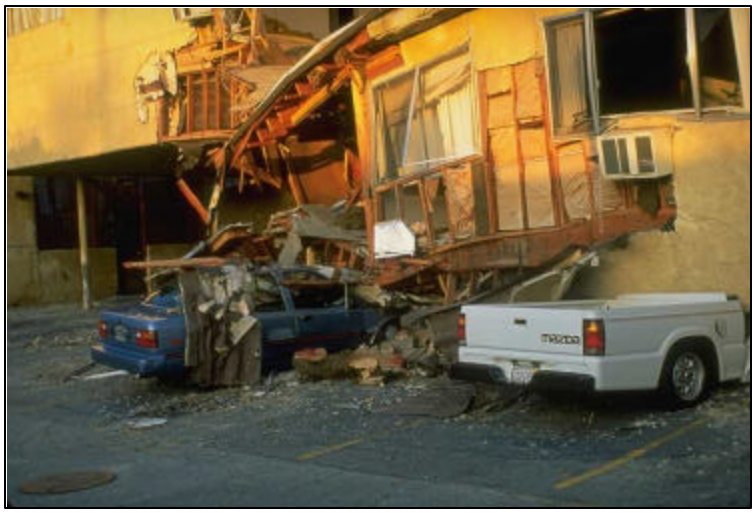
followed by a large aftershock within 6 hours on December 6, 1811. Furthermore, relieving stress along one part of the fault may increase stress in another part; the New Madrid earthquakes in January and February 1812 may have resulted from this phenomenon.

The ***focal depth*** of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the *focus*). Earthquakes with focal depths from the surface to about 70 kilometers (43.5 miles) are classified as shallow. Earthquakes with focal depths from 70 to 300 kilometers (43.5 to 186 miles) are classified as intermediate. The focus of deep earthquakes may reach depths of more than 700 kilometers (435 miles). The focuses of most earthquakes are concentrated in the crust and upper mantle. The depth to the center of the Earth's core is about 6,370 kilometers (3,960 miles), so event the deepest earthquakes originate in relatively shallow parts of the Earth's interior.

The ***epicenter*** of an earthquake is the point on the Earth's surface directly above the focus and the focus is the area of the fault where the sudden rupture takes place. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. Earthquakes beneath the ocean floor sometimes generate immense sea waves or tsunamis (Japan's dread "huge wave"). These waves travel across the ocean at speeds as great as 960 kilometers per hour (597 miles per hour) and may be 15 meters (49 feet) high or higher by the time they reach the shore. During the 1964 Alaskan earthquake, tsunamis engulfing coastal areas caused most of the destruction at Kodiak, Cordova, and Seward and caused severe damage along the west coast of North America, particularly at Crescent City, California. Some waves raced across the ocean to the coasts of Japan.

Liquefaction**,** which happens when loosely packed, water-logged sediments lose their strength in response to strong shaking, causes major damage during earthquakes. During the 1989 Loma Prieta earthquake, liquefaction of the soils and debris used to fill in a lagoon caused major subsidence, fracturing, and horizontal sliding of the ground surface in the Marina district in San Francisco.

Landslides triggered by earthquakes often cause more destruction than the earthquakes themselves. During the 1964 Alaska quake, shock-induced landslides devastated the Turnagain Heights residential development and many downtown areas in Anchorage. [xxiii]



Measuring the Severity of an Earthquake The severity of an earthquake can be expressed in terms of both ***intensity*** and ***magnitude***. However, the two terms are quite different, and they are often confused.

Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter. . Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on

observed effects. The 12 levels of the Modified Mercalli intensity may be found in Appendix H: New England and Massachusetts Climatology.

Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments which have a common calibration.

The magnitude of an earthquake is thus represented by a single, instrumentally determined value. The magnitude of seismic waves are recorded on instruments called seismographs, using **The Richter Magniture Scale.** The Richter Scale is not used to express damage. An earthquake in a densely populated area which results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that does nothing more than frighten the wildlife. Large-magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

Earthquakes with magnitude of about 2.0 or less are usually called microearthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of about 4.5 or greater--there are several thousand such shocks annually--are strong enough to be recorded by sensitive seismographs all over the world. Great earthquakes, such as the 1964 Good Friday earthquake in Alaska, have magnitudes of 8.0 or higher. On the average, one earthquake of such size occurs somewhere in the world each year. Although the Richter Scale has no upper limit, the largest known shocks have had magnitudes in the 8.8 to 8.9 range. Recently, another scale called the moment magnitude scale has been devised for more precise study of great earthquakes.

Another measure of the relative strength of an earthquake is the size of the area over which the shaking is noticed. This measure has been particularly useful in estimating the relative severity of historic shocks that were not recorded by seismographs or did not occur in populated areas. The extent of the associated felt areas indicates that some comparatively large earthquakes have occurred in the past in places not considered by the general public to be regions of major earthquake activity. For example, the three shocks in 1811 and 1812 near New Madrid, Mo., were each felt over the entire eastern United States. Because there were so few people in the area west of New Madrid, it is not known how far it was felt in that direction. The 1886 Charleston, S.C., earthquake was also felt over a region of about 2 million square miles, which includes most of the eastern United States. As more and more seismographs are installed in the world, more earthquakes can be and have been located. However, the number of large earthquakes (magnitude 6.0 and greater) has stayed relatively constant.

(Source: USGS, http://pubs.usgs.gov/gip/earthq4/severitygip.html)

Landslides – Nationwide, landslides constitute a major geologic hazard because they are widespread, occurring in all 50 states, and cause $1-2 billion in damages and more than 25 fatalities on average each year. Landslides pose serious threats to highways and structures that support fisheries, tourism, timber harvesting, mining, and energy production as well as general transportation. Landslides commonly occur with other major natural disasters such as earthquakes and floods that exacerbate relief and reconstruction efforts and expanded development and other land use has increased the incidence of landslide disasters.[xxiv]

According to the USGS, "The term **landslide** includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors." Among the contributing factors are: erosion by rivers, glaciers, or ocean waves create over steepened slopes; rock and soil slopes are weakened through saturation by snowmelt or heavy rains; earthquakes create stresses that make weak slopes fail; excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or from man-made structures may stress weak slopes to failure and other structures." USGS scientists also monitor streamflow, noting changes in sediment load carried by rivers and streams that may result from landslides. All of these types of landslides are considered aggregately in USGS mapping of landslides. [xxv]

Landslides are common throughout the Appalachian region and New England. The greatest eastern hazard is from sliding of clay-rich soils; related damages in urban areas such as Pittsburgh, PA, and Cincinnati, OH, are among the greatest in the U.S. Landslides also occur across the Great Plains and into the mountain areas of the western U.S. in weathered shales and other clay-rich rocks particularly where there are steep slopes, periodic heavy rains, and vegetation loss has occurred after wildfires. Earthquakes and volcanoes also cause landslides; the catastrophic 1980 eruption of Mount St. Helens in Washington was preceded by the by the development of a large landslide on the north side of the volcano. The Northridge earthquake in 1994 in the San Fernando Valley triggered thousands of landslides in the Santa Susanna Mountains north of the epicenter.[xxvi]

The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors:

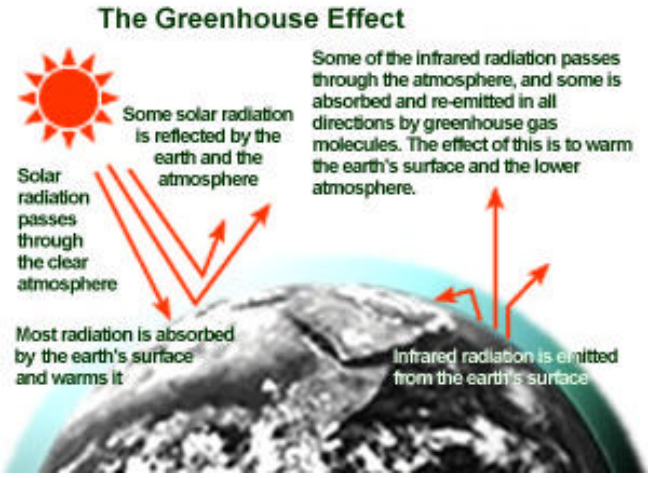
- Erosion by rivers, glaciers, or ocean waves create over steepened slopes
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains
- Earthquakes create stresses that make weak slopes fail
- Earthquakes of magnitude 4.0 and greater have been known to trigger landslides
- Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or from man-made structures may stress weak slopes to failure and other structures

(Source: http://landslides.usgs.gov/html_files/nlic/page5.html)

#6 Other Potential Hazards

Climate Change Due to Global Warming[xxvii]

According to the National Academy of Sciences, the Earth's surface temperature has risen by about 1° Fahrenheit in the past century, with accelerated warming during the past two decades. There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities. Human activities have altered the chemical composition of the atmosphere through the buildup of greenhouse gases – primarily carbon dioxide, methane, and nitrous oxide. The heat-trapping property of these gases is undisputed although uncertainties exist about exactly how earth's climate responds to them.



More detailed information may be found on the Environmental Protection Agency's website at http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html)

Global Warming Impacts on MA

(Source: Global Warming Fact Sheet for Massachusetts from the EPA, found in Appendix H and the Massachusetts Climate Protection Plan, Spring 2004)

Increased Temperature and Precipitation:

- By 2100, temperatures in Massachusetts could increase by about 4? F (with a range of 1-8? F) in winter and spring and about 5? F (with a range of 2-10? F) in summer and fall.
- By 2100, precipitation in Massachusetts is estimated to increase by about 10% in spring and summer, 15% in fall, and 20-60% in winter.

Increased Risks to Public Health

- A temperature increase of 4? F, with no other change in weather or emissions, could increase concentrations of ground-level ozone, a major component of smog, by 4%. Currently in Massachusetts, ground-level ozone concentrations already exceed national ozone health standards. Ground-level ozone aggravates respiratory illnesses such as asthma, reduces existing lung function, and induces respiratory inflammation.
- An increase could occur in Massachusetts in the transmission and/or incidence of diseases including malaria, Eastern equine encephalitis, dengue fever and Lyme disease because ticks, their rodent hosts, and mosquito populations will likely increase due to the warmer temperatures and increased vegetation.

- Warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms (so-called red tides), which are toxic to humans, and will damage Massachusetts shellfish habitat and nurseries and spread bacteria like those causing cholera.
- Warmer summer temperatures could increase water quality problems because of increased evaporation, which concentrates pollutant levels, and more favorable conditions for algae and other water organisms.

Harm from Sea Level Rise

- At Boston, sea level already is rising by 11 inches per century, and it is likely to rise another 22 inches by 2100.
- Sea level rise could cause flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges in Massachusetts[xxviii].

Technological/Man-made Disasters – Accidents & Terrorism

Technologic, or man-made, disasters are commonly defined as emergencies characterized by a sudden threat to lives, property, public health and the environment, arising from a failure of critical infrastructure systems or the release, or potential release, of oil, radioactive materials, or hazardous chemicals or bio-hazards, into the air, land or water. These emergencies may occur from transportation accidents, unusual events at facilities that use or manufacture chemicals or biological hazards, or as a result of natural or man-made events.[xxix] While these incidents are most often accidental, intentional acts of sabotage, or terrorism, must increasingly be considered as a discrete category of technological disaster.

According to a July 2003 report, ***Reducing Disaster Vulnerability through Science and Technology – an Interim Report of the Subcommittee on Disaster Reduction*** by the National Science and Technology Council, technological, or man-made disasters include the following components related to natural hazards mitigation planning:

- **Critical Infrastructure Threats -** Critical infrastructure is defined as "the linked systems of facilities and activities vital to providing services necessary to support the nation's economy and quality of life…including electrical power, medical and public health services, transportation, oil and gas production and storage, water supply, emergency services, government services, banking and finance, and telecommunications." [xxx] These systems are increasing varied and complex, and are operated with increasingly sophisticated information technology systems. The integration of aging civil infrastructure systems into larger networks and the associated loss of redundancy can lead to reduced reliability and intricate interdependencies. Failure of particular components or subsystems within this critical infrastructure can incapacitate the entire system.

- **Oil, Chemical, Bio-Hazards Spills and Accidents** Almost 14,000 oil spills are reported each year in the U.S., mobilizing thousands of specially trained emergency response personnel and challenging the best-laid contingency plans. Although many spills are contained and cleaned up by the party responsible for the spill, some spills require assistance from local and state agencies, and on occasion, the Federal Government. Similarly, the safe handling of industrial chemicals became a significant priority for disaster managers worldwide following the 1984 accident at Union Carbide's Bhopal, India, factory that killed more than 2,000 people. The most recent, and severe, chemical spills in Massachusetts occurred

on April 27, 2003 when a barge heading north in Buzzard's Bay toward the Cape Cod Canal ran aground, causing a rupture in its hull. This accident resulted in the spill of approximately 98,000 gallons of heating oil into the Bay. The spill closed shell fishing areas and beaches, causing thousands of dollars in loss wages and property damage.

- **Building Fires**. In 1999, building fires caused $10 billion in property damages, more than 4,000 deaths (including 100 firefighters) and 100,000 injuries in the U.S. The Worcester Cold Storage Fire on Dec. 3, 1999 caused the deaths of 6 Worcester, MA firefighters. In Massachusetts, the most recent fire which caused t Property losses do not account for loss of productivity and impact to the environment, secondary costs such as fire safety training, or economic implications of fire safety requirements. The number of deaths due to fire has decreased during the past 30 years as a result of revised fire standards and codes, yet property losses remain about the same as reported in 1973, when annual property losses exceeded $11 billion. Despite revised fire codes, a hundred lives were lost during the Feb. 2003 Station Nightclub Fire in Warwick, R.I. Additional revisions to both Massachusetts and Rhode Island's fire codes were made as the result of this tragedy.

Massachusetts Plans Addressing Other Potential Hazards

Although the focus of this plan is on natural hazards, Massachusetts is aware of the coordination that is needed between the State Hazard Mitigation and other statewide planning initiatives, especially related to emergency management, response and recovery. To address these types of technological and/or man-made disasters, Massachusetts has developed, or is in the process of developing the following statewide plans and strategies:

Threat	*Plan and/or Strategy*	*Date Completed*	*Responsible Agency*
Climate Change	**Massachusetts Climate Protection Plan** is an initial step in a coordinated effort to address climate change by reducing emissions of greenhouse gasses and improve energy efficiency. This plan is Massachusetts' commitment to implement the regional climate change plan adopted by the New England Governors and Easter Canadian Premiers in Aug. 2001.	Spring 2004	The Office of Commonwealth Development. This plan may be found online at **www.mass.gov/ocd**
Critical Infrastructure Threats	**The MA State Homeland Security Strategy** provides the strategic vision that will guide the development of state and regional plans to prevent and mitigate potential acts of terrorism. This strategy was submitted to the Department of Homeland Security, Office of Domestic Preparedness in accordance with requirements as defined in the FY 2004 Homeland Security Grant Program (HSGP) guidelines.	Feb. 2004	Executive Office of Public Safety This plan may be found online **www.mass.gov/ccj/download/SHSS.pdf**

Threat	*Plan and/or Strategy*	*Date Completed*	*Responsible Agency*
Critical Infrastructure Threats (continued)	**The Strategic Plan for Safeguarding the Commonwealth of Massachusetts Against Terrorism and Related Threats** is a 2002 document that outlines threats confronting the Commonwealth; describes the concrete steps taken by Massachusetts since Sept. 11, 2001 to enhance security and to protect the Commonwealth from terrorism, addresses measures that still need to be taken or continued, and sets forth a series of specific recommendations designed to guide and improve Commonwealth security in the years ahead.	Dec 2002	Executive Office of Public Safety A copy of this plan may be found at **www.mass.gov/eops/publications/strategic_plan.pdf**
	The Massachusetts Comprehensive Emergency Management Plan (CEMP) – This plan establishes the fundamental policies, basic, program strategies, assumptions and mechanisms through which the Commonwealth will mobilize resources and conduct activities to guide and support local emergency management efforts through response and recovery.	Nov. 2002	Massachusetts Emergency Management Agency (MEMA) A copy of this plan may be found at **www.mass.gov/agency/documents/mema/1102-StateCEMPlan.doc**
Oil/Chemical/ Bio-Hazards Spills and Accidents	**Emergency Planning and Community Right to Know Act (EPCRA)** establishes requirements for Federal, State and local governments, Indian Tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The Community Right-to-Know provisions help increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment.	Ongoing	Environmental Protection Agency (EPA) More information may be found at **http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/tier2.htm**

Threat	*Plan and/or Strategy*	*Date Completed*	*Responsible Agency*
Oil/Chemical/ Bio-Hazards Spills and Accidents (continued)	**Nuclear Plant Preparedness Plans** – MEMA's Nuclear Preparedness Division develops and maintains detailed radiological emergency response plans and implementing procedures for communities and facilities within the three emergency planning zones for the Plymouth, MA Seabrook, NH and Vermont/Yankee, VT nuclear plans. . All plans and procedures are reviewed annually, updated as needed, and tested through regular exercises.	Annually	MEMA
	BioTerrorism Prevents/ Public Health - Since the terrorist attacks on September 11, the ensuing anthrax incidents across the nation, and the recent escalation of the Homeland Security Advisory System's "threat condition," the Massachusetts Department of Public Health has received numerous inquiries from the public about the threat of terrorism and what precautionary measures could be taken. The following "frequently asked questions" were developed for the general public, and are consistent with guidance from the federal government and other state agencies.	Current	Massachusetts Department of Public Health **http://www.mass.gov/dph/bioterrorism/advisorygrps/faq.htm**

Threat	*Plan and/or Strategy*	*Date Completed*	*Responsible Agency*
Building Fires	**H. 4550, An Act Relative to Fire Safety in the Commonwealth,** updates MGL Chapter 148: Fire Prevention**.** This act requires the following: **1)** Mandates sprinklers in nightclubs with occupancy of 100 persons or more. **2)** Appropriates $10 million for municipalities to assist in providing firefighter safety equipment and as well as help with certain personnel and overtime expenditures incurred by departments. **3)** Establishes an accelerated tax depreciation deduction for automatic sprinkler systems required to be installed as a retrofit in existing nightclubs, discotheques, dance halls, and bars. **4)** Establishes specific criminal penalties for certain dangerous conditions in a public assembly building including: blocked ingress or egress; failure to maintain or shutting off fire protection systems; storing flammables or explosives or use of fireworks or pyrotechnics without a permit and exceeding occupancy limits. The first infraction will result in a fine of not more than $5,000 and/or by imprisonment of not more than 2 1/2 years. Subsequent infractions will result in a fine of not more than $25,000 and/or by imprisonment of up to five years. **5)** Creates a specific statutory crime for those individuals who violate provisions of the state building or fire codes when a violation results in significant injury or death. Violations will result in a fine of not more than $25,000 and/or imprisonment of up to five years. **6**) Restores the Student Awareness of Fire Education or SAFE program, which helps educate children about fire safety awareness.	August 2004	MA Department of Fire Services, **www.mass.gov/dfs/index.shtm**

4.2 Profiling Hazard Events

The aftermath of the Blizzard of 1978 in Scituate.

The purpose of the following section is to give a brief history of the most recent and significant national hazard events that have occurred in Massachusetts over the last couple of decades as well as provide descriptions of specific hazard events that have occurred, and have the potential to occur again, throughout Massachusetts.

The most significant events within Massachusetts the last 12 years include the following events:

1. **The Blizzard of 1978**
2. **Hurricane Gloria, 1985**
3. **Hurricane Bob, August 1991**
4. **October Northeaster, October 1991**
5. **December Northeaster, December 1992**
6. **Floods, October 1996**
7. **Floods, June 1998**
8. **Winter Storm & Floods, March 2001**
9. **Winter Storms, Feb. 2003 & Dec. 2003**
10. **Spring Floods, April 2004**

Boats stacked up in Cape Cod after Hurricane Bob in 1991.

Hurricane Bob and the 1991 October northeaster caused a combined total of $49 million in damage to uninsured property and infrastructure in addition to the nearly $125 million paid out by the National Flood Insurance Program (NFIP) in flood insurance claims. The December 1992 coastal storm caused more than $12.6 million in damage to the public infrastructure (roads, bridges, public facilities, public utilities, etc) which resulted in 1,874 NFIP claims in Massachusetts at a cost of nearly $12.7 million.[xxxi]

The severe rainstorm in October 1996 caught the Boston metropolitan area and eastern Massachusetts by surprise, causing more than $90 million in flood damage to private and public property. This amount included close to $50 million in damages to the MBTA system in Boston. In June 1998, another severe rain storm with subsequent flooding caused more than $9 million dollars in damage to private property owners throughout eastern Massachusetts. Approximately 92% of these damaged residences in 1998 were previously flooded during the October 1996 storms.[xxxii]

The most recent Presidential Disaster Declarations have included winter storms – a northeaster that caused flooding and heavy snowfall in late March 2001 and severe snowstorms in February 2003 and early

December 2003. The winter storm of March 2001 began as a slow moving coastal storm between March 5 and March 7, 2001 which dumped more than 2 feet of snow in the suburbs north and west of Boston, causing power outages throughout the area, and resulting in considerable coastal damage. Coastal communities, especially south of Boston, were hit with a storm surge 2 to 2 ½ feet above normal high tide in addition to the wet, heavy snow and steady winds between 38 mph to 46 mph with gusts to 52 mph. In total, nearly 5,000 residences were damaged, causing almost $8 million in damages. Massachusetts received a Presidential disaster declaration for Individual Assistance on April 10, 2001.[xxxiii] The February 2003 snowstorm affected the entire state and federal assistance of $29 million was provided for snow removal costs in all 14 counties in the Commonwealth. This was followed by another winter snowstorm in early December 2003 which affected 12 out of the 14 counties and requiring nearly $23 million in federal assistance.

The following chart gives an overview of the most recent type of disasters which have led to Presidential and State Disaster Declarations in Massachusetts over the past 12 years.

Declared Massachusetts Disaster Events 1972 – 2004

Disaster Name (Date of Event)	***Disaster Number (Type of Assistance)***
Severe Storms& Flooding (March 1972)	Federal 325 (Individual)
Fire (City of Chelsea) (October 1973)	Federal 405 (Individual & Public)
Coastal Storms, Flooding, Ice & Snow (February 1978)	Federal 546 (Individual & Public)
Hurricane Gloria (September 1985)	FEMA 751 (Public)
Severe Storms & Flooding (April 1987)	FEMA 790 (Individual & Public)
Hurricane Bob (August 1991)	FEMA 914 (Individual & Public)
No-Name/Coastal Storm (Oct. 1991)	FEMA 920 (Individual & Public)
Winter Coastal Storm (December 1992)	FEMA 975 (Public)
March Blizzard (March 1993)	FEMA 3103 (Public)
April Flood (April 1993)	State (Public)
Microburst Storm (July 1994)	State (Public)
Berkshire Tornado (May 1995)	State (Public)
Russell/Montgomery Wild Fire (September 1995)	FEMA-2116 (Public) State (Public)
January Blizzard (January 1996)	FEMA 1090 (Public)
May Windstorm (May 1996)	State (Public)
Franklin County Rainstorm (June 1996)	State (Public)
October Flood (October 1996)	FEMA 1142(Individual & Public) Hazard Mitigation Grant Program Community Development Block Grant

Disaster Name (Date of Event)	*Disaster Number (Type of Assistance)*
June Flood (June 1998)	FEMA 1224 (Individual) Hazard Mitigation Grant Program Community Development Block Grant
Worcester Fire (December 3, 1999)	FEMA 3153 (Public)
Tropical Storm Floyd (Sept. 16 – 17, 1999)	State (Public)
June Rainstorm (June 25, 2000)	State (Public)
July Rainstorm (July 15 – 16, 2000)	State (Public)
March Flood (March 2001)	FEMA 1364 (Individual) Hazard Mitigation Grant Program
March Blizzard (March 2001)	FEMA 3165 (Public)
Aftermath Tropical Storm Allison (June 17, 2001)	State (Public)
June/July Rainstorm (June 30 – July 1, 2001)	State (Public)
February Blizzard (Feb. 17-18, 2003)	FEMA 3175 EM (Public)
December Snowstorm (Dec. 3 & 4, 2003)	FEMA 3191 EM (Public)
Spring Floods April 2004	FEMA 1512 (Individual)

Source: *MEMA Disaster Recovery Division Report, June 2004 & FEMA, www.fema.gov, Jan. 2004.*

It is interesting to note the following about the 29 disaster declarations since 1972:

- 10 were state disaster declarations
- 19 were federal, or Presidential, disaster declarations
- 18 events, or 62%, of these disaster declaration involved major flood events
- 7 disasters, or 24%, involved high wind events
- 7 disasters, or 24%, were blizzards or major snowstorms
- 3 disasters, or 10%, were major fires.

Note: The above totals add up to more than 100% due to the fact that some disaster declarations include more than one natural hazard. Additional information on large scale disaster events in Massachusetts may be found in Appendix H, New England and Massachusetts Climatology.

Massachusetts coastal communities felt the fury of the March 2001 northeaster.

Vulnerability to Future Natural Hazards Based on the identification and profile of the natural hazards that have occurred, or may potentially occur, in Massachusetts, and on the State Risk & Vulnerability Assessment by Dewberry , the following natural hazards Vulnerability Chart has been developed. The yellow, or shaded areas, indicate the highest level of frequency and severity of each hazard. *(Note: This State Plan will be updated to include any new hazard frequency and severity provided in the multi-jurisdictional plans by the regional planning agencies and this chart will be revised as needed to reflect this new information).*

Massachusetts Potential Vulnerability to Future Natural Hazards

Hazard	Frequency				Severity			
Flood	Very Low	Low	Medium	**High**	Minor	**Serious**	**Extensive***	Catastrophic
Dam Failure	Very Low	**Low**	Medium	High	Minor	Serious	**Extensive**	Catastrophic
Coastal Storms	Very Low	Low	Medium	**High**	Minor	Serious	**Extensive**	**Catastrophic***
Coastal erosion	Very Low	Low	Medium	**High**	Minor	**Serious**	Extensive	Catastrophic
Hurricanes & Tropical Storms	Very Low	Low	**Medium**	High	Minor	Serious	**Extensive**	**Catastrophic***
Severe Storms (wind, hail, lightning)	Very Low	Low	**Medium**	High	Minor	**Serious**	Extensive	Catastrophic
Tornados	Very Low	Low	**Medium**	High	Minor	Serious	**Extensive**	**Catastrophic***
Severe Winter Weather (wind, snow, ice)	Very Low	Low	Medium	**High**	Minor	Serious	**Extensive**	Catastrophic
Drought	Very Low	Low	**Medium**	High	Minor	**Serious**	Extensive	Catastrophic
Fire (wild)	Very Low	Low	**Medium**	High	Minor	**Serious**	Extensive	Catastrophic
Earthquake	Very Low	**Low**	Medium	High	Minor	Serious	Extensive	**Catastrophic**
Landslide	Very Low	**Low**	Medium	High	**Minor**	Serious	Extensive	Catastrophic

* Two ranges of severity due to WHERE the hazard and WHEN the hazard affects an area. A coastal storm, a flood, a hurricane, and severe winter weather have the potential for a catastrophic event if each where to strike a highly populated area during an astronomical high tide. Also, should a hurricane reach a Category 5, the strongest hurricane wind-strength (wind speeds of > 155 miles per hour), or a tornado reach an F5 category with wind speeds of 261-318 mph, there is the potential for a catastrophic event

Criteria for frequency categorization:

- **Very low frequency**: events that occur less frequently than once in 1,000 years (less than 0.1% per year)
- **Low frequency**: events that occur from once in 100 years to once in 1,000 years (0.1% to 1% per year);
- **Medium frequency**: events that occur from once in 10 years to once in 100 years (1% to 10% per year);
- **High frequency**: events that occur more frequently than once in 10 years (greater than 10% per year).

(Source: FEMA, July 2003 Attachment II: Supplemental questions for National Ranking and Evaluation, Pre-Disaster Mitigation Program FY 2003

Criteria for severity categorization (based on past hazard events):

- **Minor:** Limited and scattered property damage; no damage to public infrastructure (roads, bridges, trains, airports, public parks, etc.); contained geographic area (i.e. one or two communities); essential services (utilities, hospitals, schools, etc.) not interrupted; no injuries or fatalities.

- **Serious**: Scattered major property damage (more than 50% destroyed); some minor infrastructure damage; wider geographic area (several communities); essential services are briefly interrupted; some injuries and/or fatalities

- **Extensive:** Consistent major property damage; major damage public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and fatalities.

- **Catastrophic**: Property and public infrastructure destroyed; essential services stopped; thousands of injuries and fatalities.

4.3 Assessing Vulnerability by Jurisdiction

In the previous section, the natural hazards that have occurred, and are most likely to occur, in Massachusetts, have been described and reviewed. This section will provide additional information on *where* natural hazards have occurred, or are most likely to occur, as well as identifying what resources (people, structures, economic) may be located in high risk areas.

The State Hazard Mitigation Team, with funding through FEMA's Pre-Disaster Mitigation (PDM) program in 2002 retained the services of The Dewberry Company in order to develop a more detailed statewide vulnerability assessment and based on the best available data at that time (as of 2003). This section incorporates Dewberry's research and GIS maps of the state's vulnerability to the natural hazards previously described in Sections 4.1 and 4.2 of this plan.

The following section is based on the best available statewide data which is not necessarily specific to separate jurisdictions, or municipalities. As the regional planning agencies (RPAs) develop and complete their regional hazard mitigation plans with local annexes in late 2004 and early 2005, the Massachusetts State Hazard Mitigation will incorporate this new regional and local information into this State Hazard Mitigation Plan as it becomes available. This incorporation of regional and local natural hazards risks

assessment is part of Massachusetts statewide hazard mitigation planning strategy (as outlined in Section 3.2 of this plan).

The schedule for incorporating this regional and local information, especially risk assessment data, into this state plan is as follows:

Regional Planning Agency	***Plan Due Date***	***State Plan Analysis & Inclusion***
Berkshire Regional Planning Commission (BRPC)	**July 2005**	**Nov. 2005**
Cape Cod Commission (CCC)	**December 2004**	**May 2005**
Franklin Regional Council of Governments (FRCOG)	**December 2004**	**May 2005**
Metropolitan Area Planning Council (MAPC)	**December 2004**	**May 2005**
Northern Middlesex Council of Governments (NMCOG)	**July 2005**	**Nov. 2005**
Old Colony Planning Council (OCPC)	**July 2005**	**Nov. 2005**
Southeastern Regional Planning and Economic Development District (SRPEDD)	**December 2004**	**May 2005**

.

Mitigation Success Story

Drainage Project Relieves Annual Flooding in Groveland

A network of underground ditches and drains in the Town of Groveland had local officials scratching their heads. Little was known about their actual courses or when the drains were constructed, most likely over 100 years ago. It was known that the poor performance of the drainage caused mosquito problems and extensive flooding to houses along the west side of Main Street during storm events.

Flood related damages to public and private property because of drainage system failure averaged over $120,000 per year for the last 20 years. An October 1996 federally declared flood caused over $570,000 in damages. Town officials decided to take action.

In 1998 the Town applied for HMGP funds that were made available following the declared disaster of 1996 (FEMA DR-1142-MA). A new defined channel was constructed east of Marjorie Street; culverts were installed at Marjorie Street, Main Street and three driveways; and existing 24-inch clay drain lines were upgraded to 48 inch RCP.

Since the completion of the project in October 2001, none of the houses previously flooded have had any problems.

The extensive flooding, which inundated homes and blocked roads in 1996, has been eliminated.

"The project improved the value of these homes, since they are no longer flooding. Prior to this, many residents were trying to sell (their houses) and move," said Robert Arakelian, Groveland Road Commissioner.

Overview of Massachusetts' Natural Hazards Vulnerability

Since 1972, there have been 19 federal disaster declarations and 10 state disaster declarations in the Commonwealth of Massachusetts. The following chart and map provide the backup data for this statement. It is this information, plus all the natural hazards maps developed by The Dewberry Company (all of these maps are in Appendices E & F)for the update Massachusetts' risk assessment which is used throughout this section which describes the Massachusetts areas at the highest risk for specific natural hazards based on the best available data at this time.

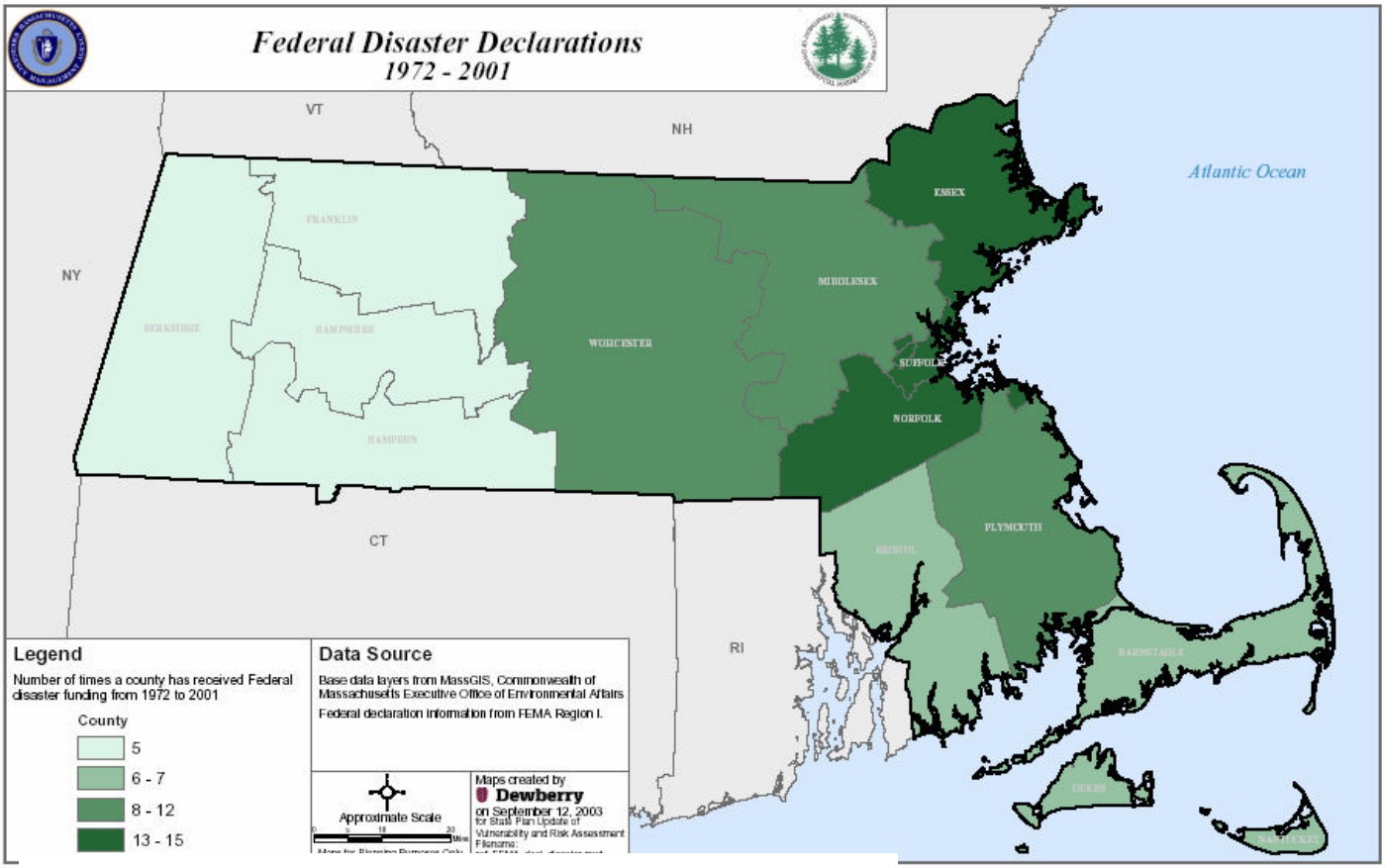
Declared Natural Disaster Events in Massachusetts 1972– 2004

DISASTER NAME (DATE OF EVENT)	DISASTER # (TYPE OF ASSISTANCE)	DECLARED AREAS
Hurricane Bob (August 1991)	FEMA-914 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, M Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk(16 projects)
No-Name Storm (October 1991)	FEMA-920 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	FEMA-920 (Individual)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
December Blizzard (December 1992)	FEMA-975 (Public)	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk (7 projects)
March Blizzard (March 1993)	FEMA-3103 (Public)	All 14 Counties
April Flood (April 1993)	STATE (Public)	Town of Hadley
Microburst Storm (July 1994)	STATE (Public)	Town of Greenfield
Berkshire Tornado (May 1995)	STATE (Public)	Towns of Edgemont, Great Barrington, Monterey, and DEM, National Guard

DISASTER NAME (DATE OF EVENT)	DISASTER # (TYPE OF ASSISTANCE)	DECLARED AREAS
Russell/Montgomery Fire (September 1995)	FEMA-2116 (Public)	DEM, National Guard
	STATE (Public)	Towns of Russell, Blandford, Cummington, Huntington, Montgomery, Southampton
January Blizzard(January 1996)	FEMA-1090 (Public)	All 14 Counties
May Windstorm (May 1996)	STATE (Public)	Counties of Plymouth, Norfolk, Bristol (27 communities)
Franklin County Rainstorm (June 1996)	STATE (Public)	Towns of Montague, Leverett, Shutesbury, Conway, Wendell, DEM, National Guard
October Flood (October 1996)	FEMA-1142 (Public)	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA-1142 (Individual)	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)
(1997)	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
June Flood (June 1998)	FEMA-1224 (Individual)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)
(1998)`	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Worcester Fire (December 3, 1999)	FEMA-3153 (Public)	City of Worcester, State Fire Mobilization Communities, State Agencies
Tropical Storm Floyd (September 16-17, 1999)	STATE (Public)	Counties of Hampden, Hampshire, Franklin, Worcester (23 communities)
June Rainstorm (June 25, 2000)	STATE (Public)	Towns of Adams, Cheshire, New Ashford, North Adams and Williamstown
July Rainstorm (July 15-16, 2000)	STATE (Public)	Town of Heath

DISASTER NAME (DATE OF EVENT)	DISASTER # (TYPE OF ASSISTANCE)	DECLARED AREAS
March Flood (March 2001)	FEMA-1364 (Individual)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (16 projects)
March Blizzard(March 2001	FEMA-3165 (Public)	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk and Worcester
Aftermath TS Allison (June 17, 2001)	STATE (Public)	Towns of Hampden, Leominster, Monson, Princeton and Wilbraham
June/July Rainstorm (June 30-July 1, 2001)	STATE (Public)	Towns of Bellingham, Millis and Walpole
Terrorist Attack (Sept 11, 2001)	FEMA-1391 (Individual)	Massachusetts residents who requested crisis counseling services following Sept 11th.
February Snowstorm (Feb 17-18, 2003)	FEMA-3175-EM (Public)	All 14 Counties
December Snowstorm (Dec. 3 & 4, 2003)	FEMA 3191 EM (Public)	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester
April Floods (April 22, 2004)	FEMA-1512 (Individual)	Counties of Essex, Middlesex, Norfolk, Suffolk, Worcester

Source: *Massachusetts Emergency Management Agency, Disaster Recovery Division Report, Sept. 2003.*

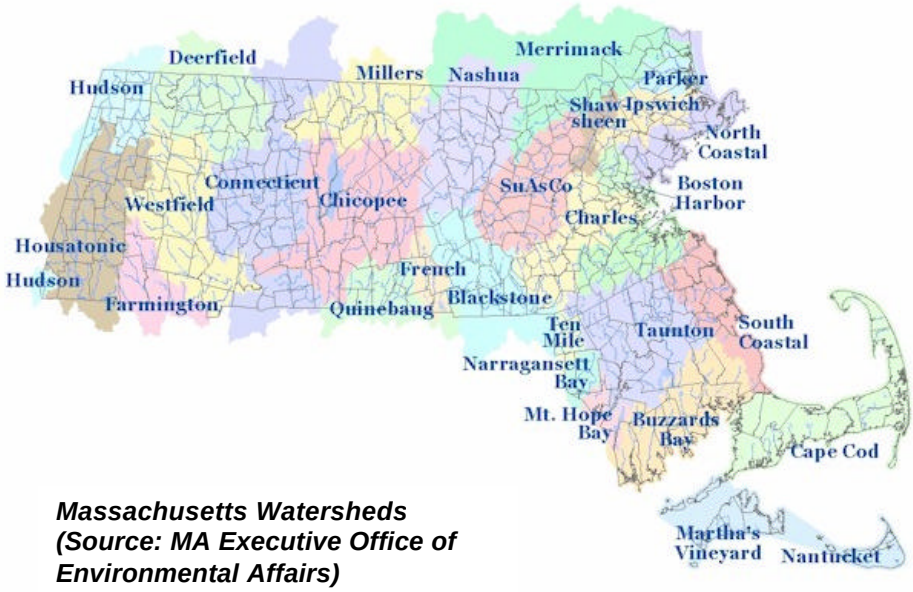


A larger version of the above map may be found in Appendix F.

Areas Vulnerable to Flood-Related Hazards

Flooding is the number one natural hazard in Massachusetts. As of December 2003, there are approximately 40,000 National Flood Insurance (NFIP) policies in-force in Massachusetts with more than $28 million in coverage. Since 1978, there have been a total of 18,226 NFIP claims paid, with nearly $215 million in total payments. In addition, Massachusetts is one of the top 10 states that account for 76% of all repetitive loss buildings in the United States.[xxxiv] In FEMA's recent list of the National Flood Insurance Program's (NFIP) Significant Flood Events Report, 1978 – 2003, 13 out of the 79 large flood events, or about 17%, affected Massachusetts (this complete list is found in Appendix H, Massachusetts and New England Climatology).

Areas At Risk for Riverine Flooding –Riverine flooding is most likely along major rivers and streams and because of Massachusetts' abundance of these waterways, most communities are at some risk of flooding. The following map shows Massachusetts' major watersheds, rivers and coastline **(**larger version of this map may be found in Appendix E**).**



Massachusetts Watersheds (Source: MA Executive Office of Environmental Affairs)

Areas At Risk for Coastal Flooding - Massachusetts is exposed to coastal flooding along its 1,500 miles of coastline shoreline from the New Hampshire border, all of Cape Cod and the southeaster coast towards the border with Rhode Island, encompassing 78 communities. There is increased concern about coastal flooding due to the fact that, over the last thirty years, the population of the Massachusetts coastal zone grew proportional to the Commonwealth's population with the coastal population remaining a third, or about 2,126,101 people, out of Massachusetts total population of 6,379,304 (2001 U.S. Census estimate).

The 2003 Massachusetts Ocean Management Task Force Study, *Trends in the Demographics of Human Population & the Massachusetts Marine Economy*, gives an overview of population trends in coastal communities. In the 1970s, the population migrated out of coastal urban areas into rural coastal communities of the Cape, Islands and Plymouth counties. In the 1980s, the migration tread out of the urban counties slowed, and stopped, but immigration into the rural coastal communities of the Cape, Islands and other coastal counties continued. The 1990s saw population growth in urban coastal areas, and immigration into rural coastal communities continued. So, while urban coastal populations decreased and then grew anew, rural coastal communities in all coastal communities grew over three decades.

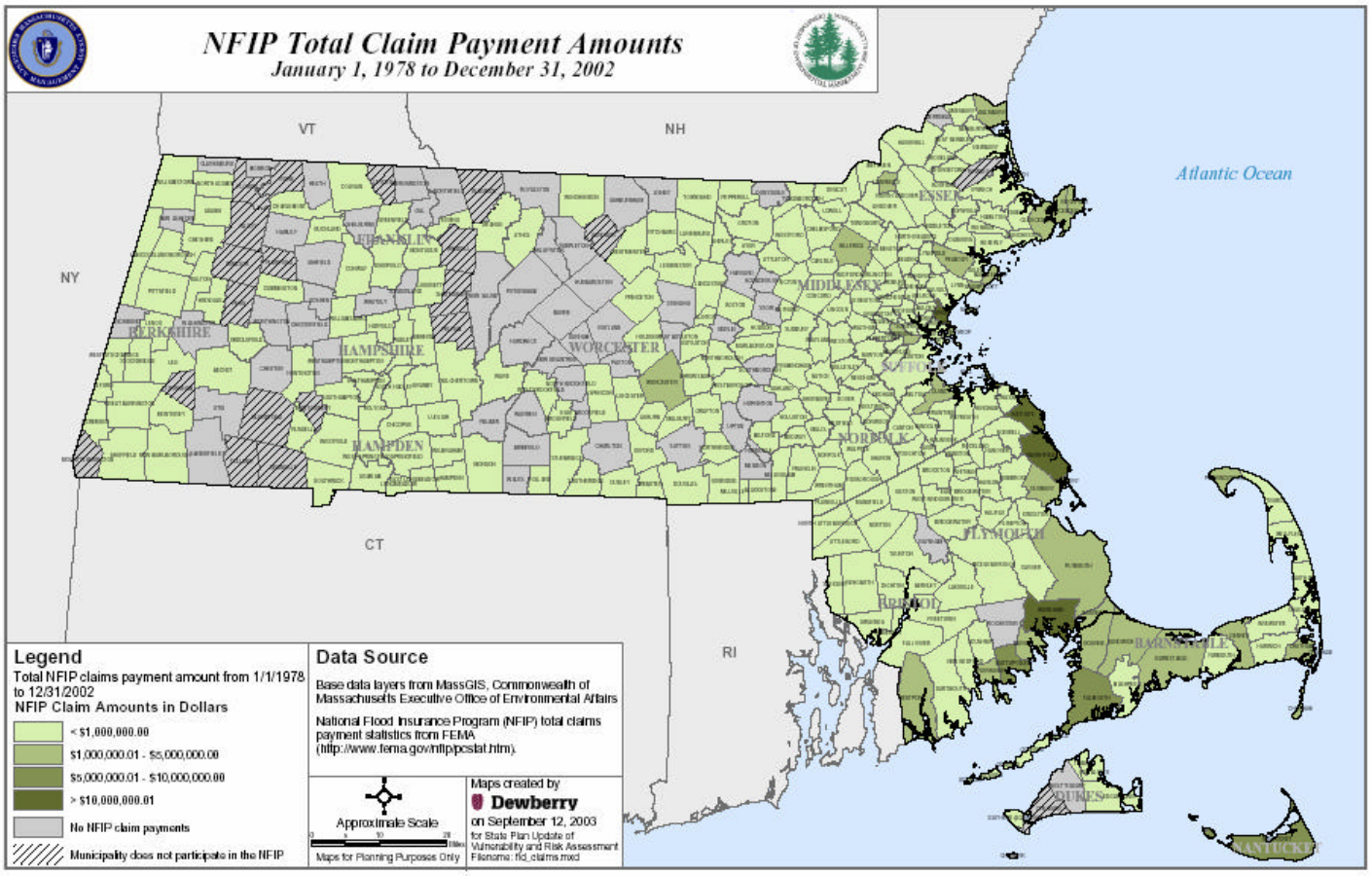
Data from the National Flood Insurance Program (NFIP)

The NFIP flood studies and flood maps as well as NFIP flood policy and claim information provide an indicator of the areas in Massachusetts most likely to be affected by flooding.

NFIP Total Claim Amounts from 1978 – 2002

The map below is a thematically shaded map of dollar range values of the National Flood Insurance Program (NFIP) insurance claims, by Massachusetts municipalities, for the period of January 1, 1978 to December 31, 2002. This map provides an overview of where the majority of flood damage occurs as well as an approximate dollar value on the damages. It should be noted that these maps and corresponding figures, however, do not take into account any of the uninsured losses caused by flooding. A larger version of this map may also be found in Appendix F.

Claim payment totals by NFIP-participating municipalities came directly from FEMA's website. Updated statistics on NFIP claims and policies in Massachusetts can be located on FEMA's website at http://www.fema.gov/nfip/pcstat.shtm.



NFIP Repetitive Losses

Another measure of an area's vulnerability to flooding is the location of "repetitive loss" properties. The NFIP identifies a repetitive loss property as one which has received flood insurance claim payments greater than $1000, twice in any 10 year period. The top 30 repetitive flood loss communities in Massachusetts, as of September 2002, are listed below:

Massachusetts Top 30 Repetitive Flood Loss Communities

Community	*Repetitive Loss Properties*	*Repetitive Loss Claims*
Scituate	484	1348
Revere	256	797
Hull	220	612
Marshfield	144	364
Winthrop	127	325
Quincy	126	337
Nantucket	43	100
Nahant	42	112
Duxbury	39	102
Swampscott	37	105
Billerica	36	94
Plymouth	34	85
Falmouth	31	69
Newton	28	74
Gloucester	23	67
Peabody	22	70
Weymouth	22	52
Salisbury	20	55
Marblehead	19	55
Dennis	19	46
Wareham	18	47
Barnstable	18	42
Rockport	16	42
Worcester	15	46
Fairhaven	15	40
Sandwich	15	31
Bourne	14	30
Arlington	14	28
Mattapoisett	13	33
Yarmouth	13	29
Newbury	12	28
Winchester	12	27
Totals	***1947***	***5292***

Source: FEMA, National Flood Insurance Program, 2003.

The Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108-264) established a new subset of repetitive loss properties known as "severe repetitive loss properties." A severe repetitive loss property is defined as one which has had four or more flood insurance claim payments of greater than $5000, or two claim payments that cumulatively exceed the value of the property. An unofficial application of this definition to the claim history in FEMA's NFIP database, performed by DCR staff, estimates that there are a total of 215 severe repetitive loss properties in Massachusetts. Seven Massachusetts communities contain 5 or more severe repetitive loss properties: Scituate (96), Revere (22), Marshfield (14), Nantucket (9), Duxbury (7), Hull (7), and Plymouth (5).

Flood Zones - National Flood Insurance Rate Maps (FIRMs)

The FEMA's Flood Insurance Rate Maps, or FIRMs, are available for the majority of Massachusetts' communities. These maps, produced for NFIP participating communities, depict the highest riverine and coastal flood risk areas. For the purposes of this plan, an overview of these maps on a statewide basis has been produced for the Commonwealth by the Dewberry Company in order to give a statewide overview of Massachusetts' flood risk. These maps (larger versions found in Appendix X) include the following:

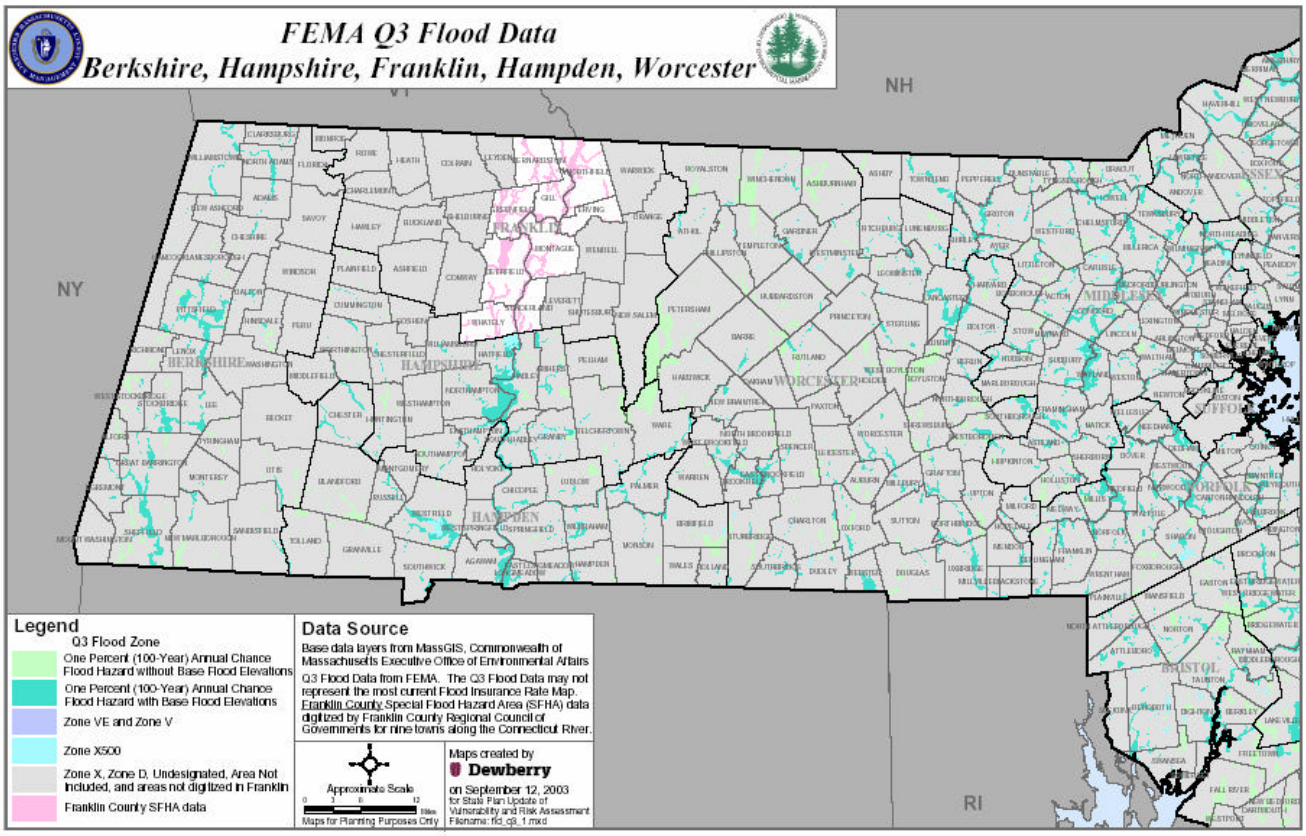
FEMAQ3 flood zones

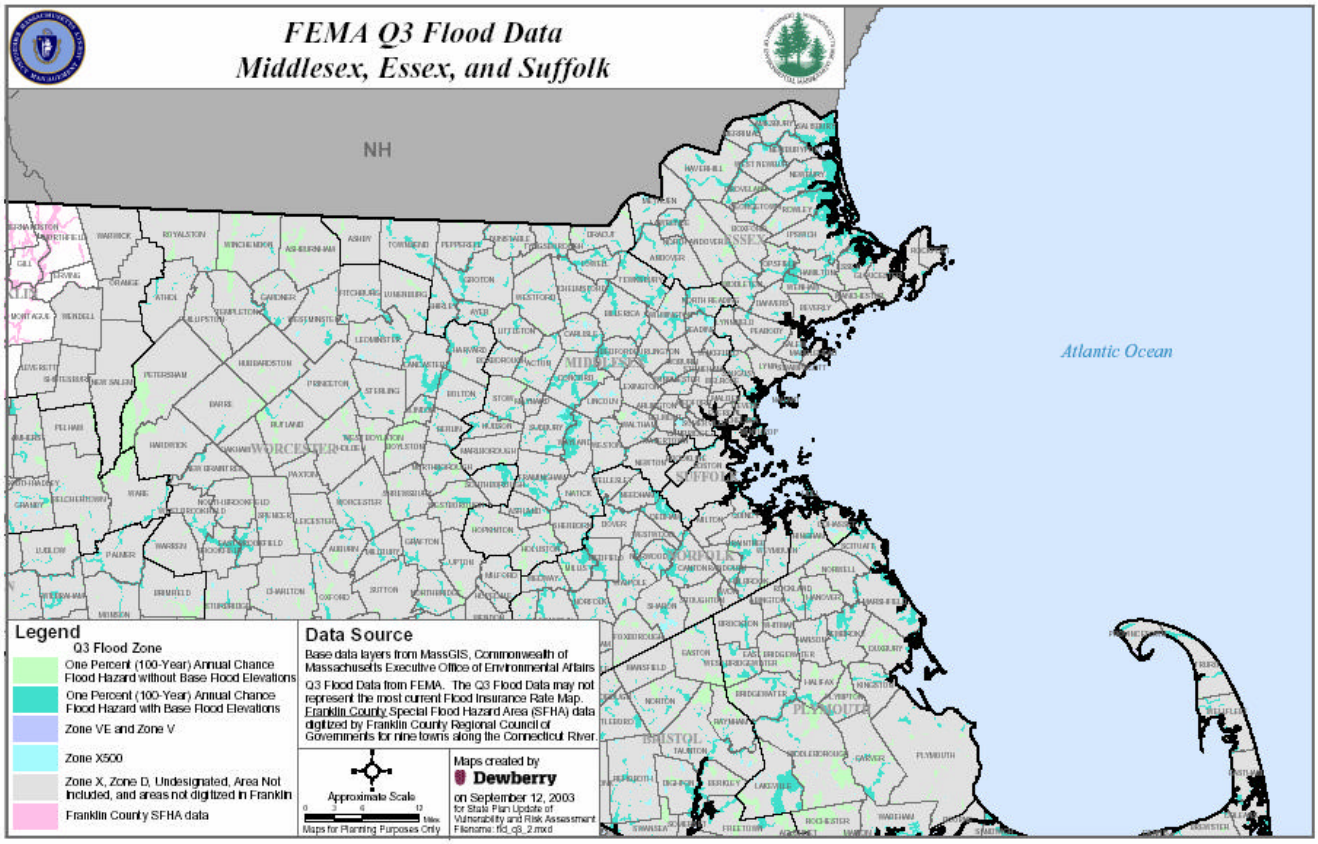
The FEMAQ3 flood zones are the digitized maps of the paper National Flood Insurance (NFIP) flood maps developed by FEMA during the 1970s, 1980s and early 1990s. These maps, digitized in the 1990s, are minimally geo-referenced and are therefore usable for large-scale planning purposes only. This product consists of four maps of regions including:

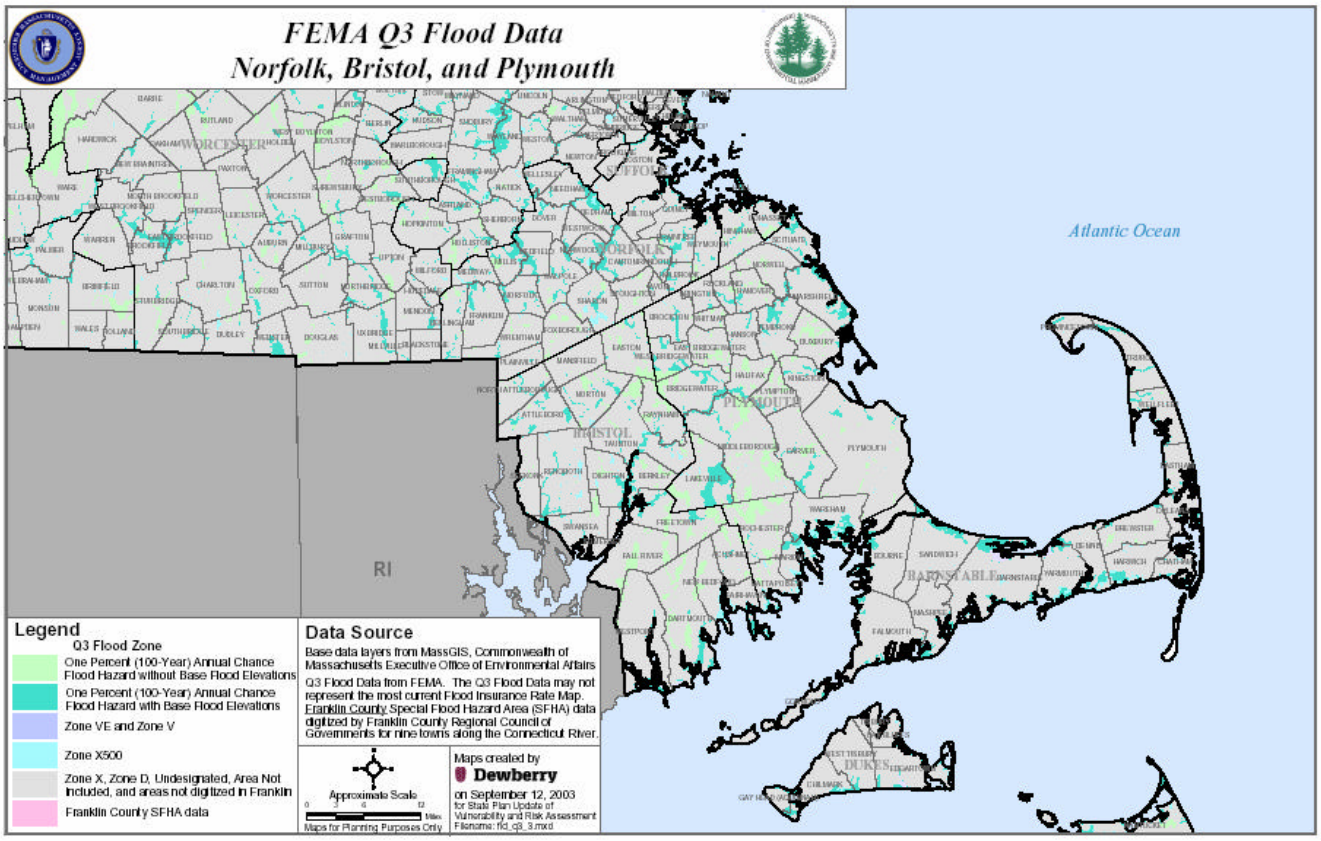
- Berkshire, Franklin, Hampden, Hampshire, and Worcester Counties
- Middlesex, Essex, and Suffolk Counties
- Norfolk, Bristol, and Plymouth Counties
- Barnstable, Dukes, and Nantucket Counties

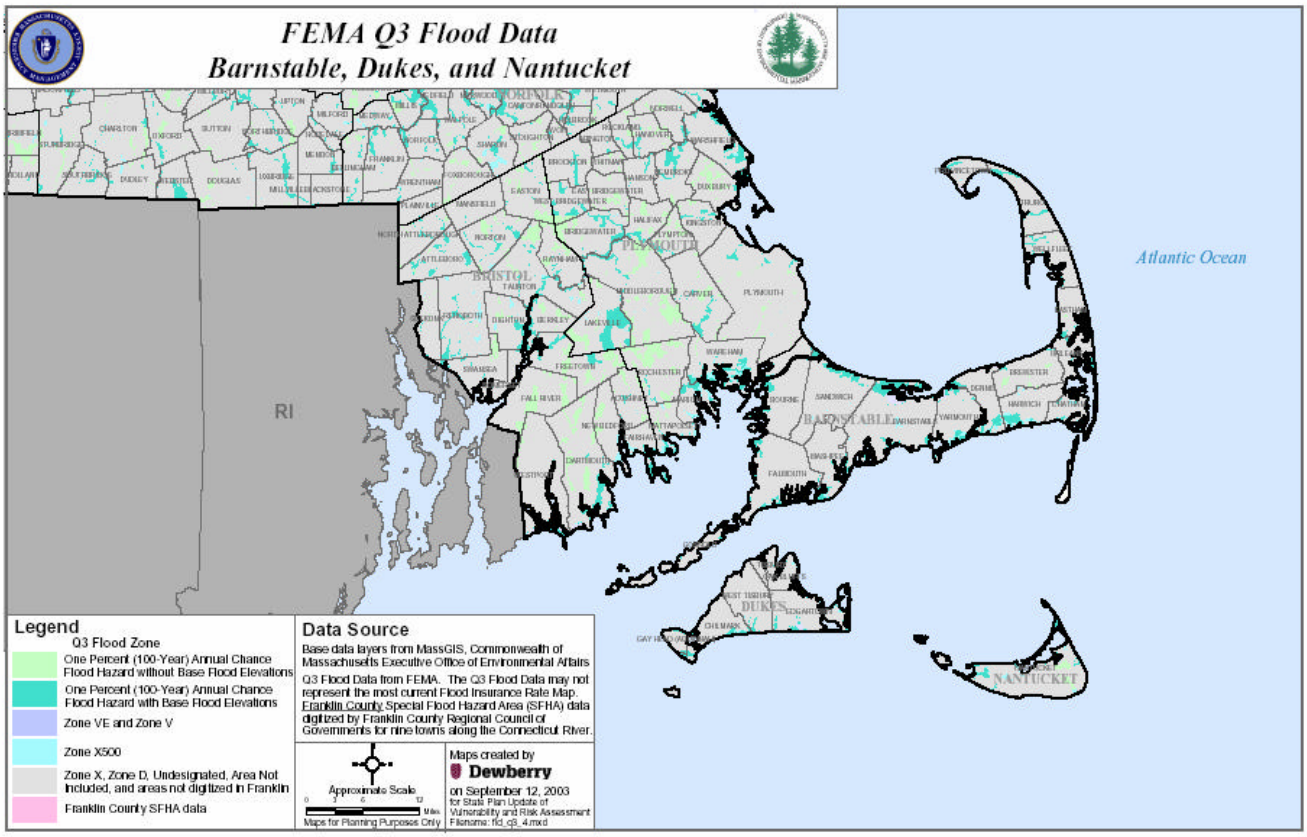
The maps consist of combinations of the FEMA flood theme layers over Massachusetts base maps with municipal boundaries to create thematically shaded flood zones. FEMA Q3 flood data was available for the entire state except Franklin County. The Franklin Regional Council of Governments (FRCOG) has digitized the one-hundred year flood zones only from the paper maps for nine communities along the Connecticut River as part of a regional planning project. The Dewberry Company, under contract by the Commonwealth, obtained the digital data from the FRCOG and added it to the map of that region. It should be noted that that the FRCOG flood data on the map does not represent all FEMA mapped floodplains in the County.

Larger versions of all the following flood hazard and NFIP maps for the different MA regions may be found in Appendix G: MA Statewide Natural Hazards Maps (Dewberry).


FEMA Q3 Flood Data
Berkshire, Hampshire, Franklin, Hampden, Worcester
NH
NY
RI
Legend
Q3 Flood Zone
One Percent (100-Year) Annual Chance Flood Hazard without Base Flood Elevations
One Percent (100-Year) Annual Chance Flood Hazard with Base Flood Elevations
Zone VE and Zone V
Zone X500
Zone X, Zone D, Undesignated, Area Not Included, and areas not digitized in Franklin
Franklin County SFHA data
Data Source
Base data layers from MassGIS, Commonwealth of Massachusetts Executive Office of Environmental Affairs
Q3 Flood Data from FEMA. The Q3 Flood Data may not represent the most current Flood Insurance Rate Map. Franklin County Special Flood Hazard Area (SFHA) data digitized by Franklin County Regional Council of Governments for nine towns along the Connecticut River.
Approximate Scale
Maps for Planning Purposes Only
Maps created by
Dewberry
on September 12, 2003
for State Plan Update of Vulnerability and Risk Assessment
Filename: fld_q3_1.mxd

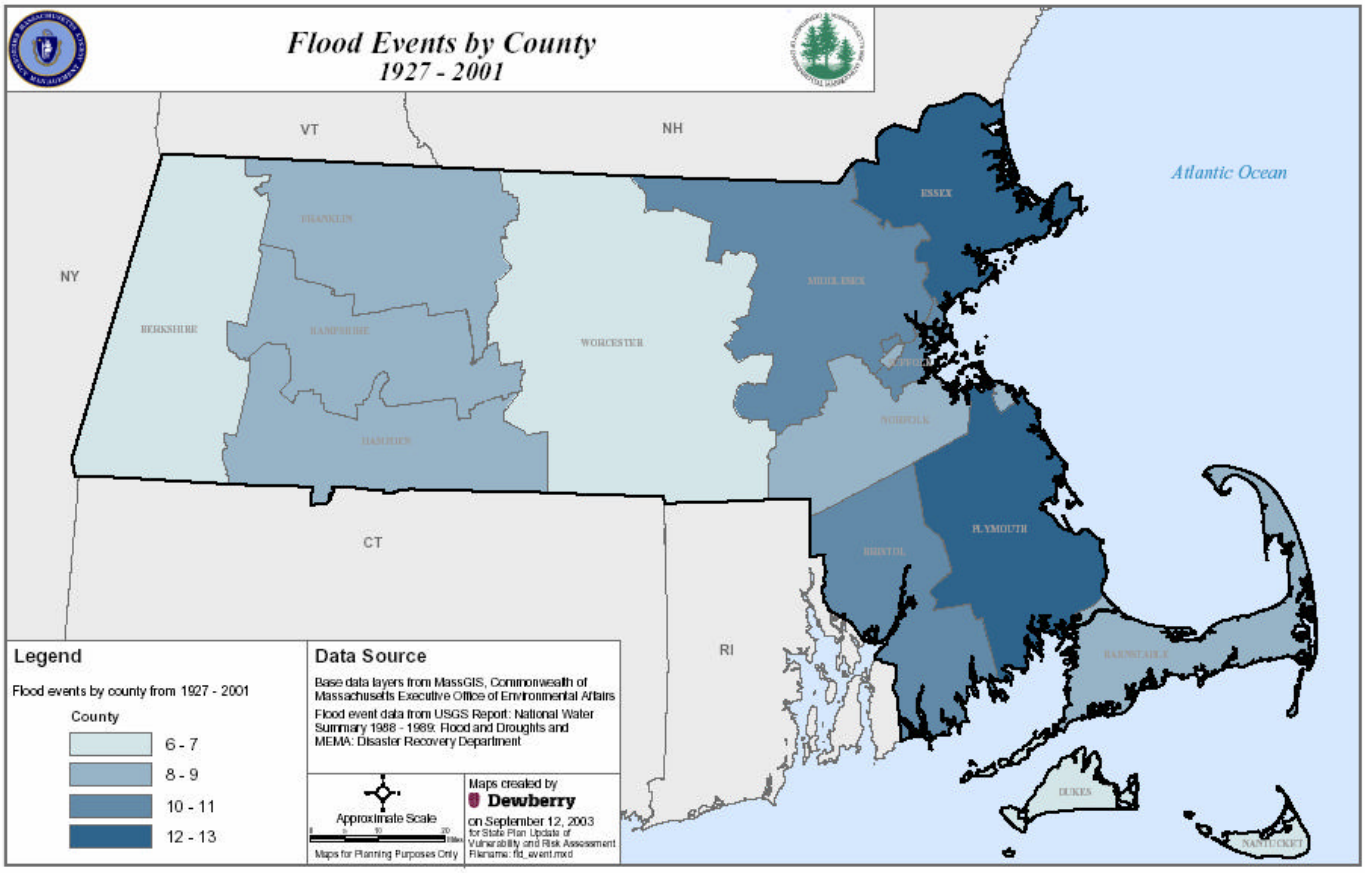

FEMA Q3 Flood Data
Middlesex, Essex, and Suffolk
NH
Atlantic Ocean
Legend
Q3 Flood Zone
One Percent (100-Year) Annual Chance Flood Hazard without Base Flood Elevations
One Percent (100-Year) Annual Chance Flood Hazard with Base Flood Elevations
Zone VE and Zone V
Zone X500
Zone X, Zone D, Undesignated, Area Not Included, and areas not digitized in Franklin
Franklin County SFHA data
Data Source
Base data layers from MassGIS, Commonwealth of Massachusetts Executive Office of Environmental Affairs
Q3 Flood Data from FEMA. The Q3 Flood Data may not represent the most current Flood Insurance Rate Map. Franklin County Special Flood Hazard Area (SFHA) data digitized by Franklin County Regional Council of Governments for nine towns along the Connecticut River.
Approximate Scale
Maps for Planning Purposes Only
Maps created by
Dewberry
on September 12, 2003
for State Plan Update of Vulnerability and Risk Assessment
Filename: fld_q3_2.mxd


FEMA Q3 Flood Data
Norfolk, Bristol, and Plymouth
Atlantic Ocean
RI
Legend
Q3 Flood Zone
One Percent (100-Year) Annual Chance Flood Hazard without Base Flood Elevations
One Percent (100-Year) Annual Chance Flood Hazard with Base Flood Elevations
Zone VE and Zone V
Zone X500
Zone X, Zone D, Undesignated, Area Not Included, and areas not digitized in Franklin
Franklin County SFHA data
Data Source
Base data layers from MassGIS, Commonwealth of Massachusetts Executive Office of Environmental Affairs
Q3 Flood Data from FEMA. The Q3 Flood Data may not represent the most current Flood Insurance Rate Map.
Franklin County Special Flood Hazard Area (SFHA) data digitized by Franklin County Regional Council of Governments for nine towns along the Connecticut River.
Approximate Scale
Maps for Planning Purposes Only
Maps created by
Dewberry
on September 12, 2003
for State Plan Update of Vulnerability and Risk Assessment
Filename: fld_q3_3.mxd


FEMA Q3 Flood Data
Barnstable, Dukes, and Nantucket
Atlantic Ocean
RI
NANTUCKET
Legend
Q3 Flood Zone
One Percent (100-Year) Annual Chance Flood Hazard without Base Flood Elevations
One Percent (100-Year) Annual Chance Flood Hazard with Base Flood Elevations
Zone VE and Zone V
Zone X500
Zone X, Zone D, Undesignated, Area Not Included, and areas not digitized in Franklin
Franklin County SFHA data
Data Source
Base data layers from MassGIS, Commonwealth of Massachusetts Executive Office of Environmental Affairs
Q3 Flood Data from FEMA. The Q3 Flood Data may not represent the most current Flood Insurance Rate Map.
Franklin County Special Flood Hazard Area (SFHA) data digitized by Franklin County Regional Council of Governments for nine towns along the Connecticut River.
Approximate Scale
Maps for Planning Purposes Only
Maps created by
Dewberry
on September 12, 2003
for State Plan Update of Vulnerability and Risk Assessment
Filename: fld_q3_4.mxd

Flood Events by County, 1927 – 2001

The following map is based on several sources of information, but the *USGS Report: National Water Summary: Floods and Droughts - Massachusetts*, dated 1988-1989, provided the most data on past flood events in Massachusetts. Of all the sources, some data was captured by county, some by watershed or more specific affected area. Using all the data sources collapsed into one table, which included type of event, date of event and approximate extents of flooding, the number of events was mapped by county and by basin. Given all of this data and the challenge of creating a "readable" map, the decision was made to map flood events by county only. Dewberry used maps and knowledge of the areas to convert all of the watershed-based events into the correct counties on the map and produced a thematically shaded map of number of events by county.



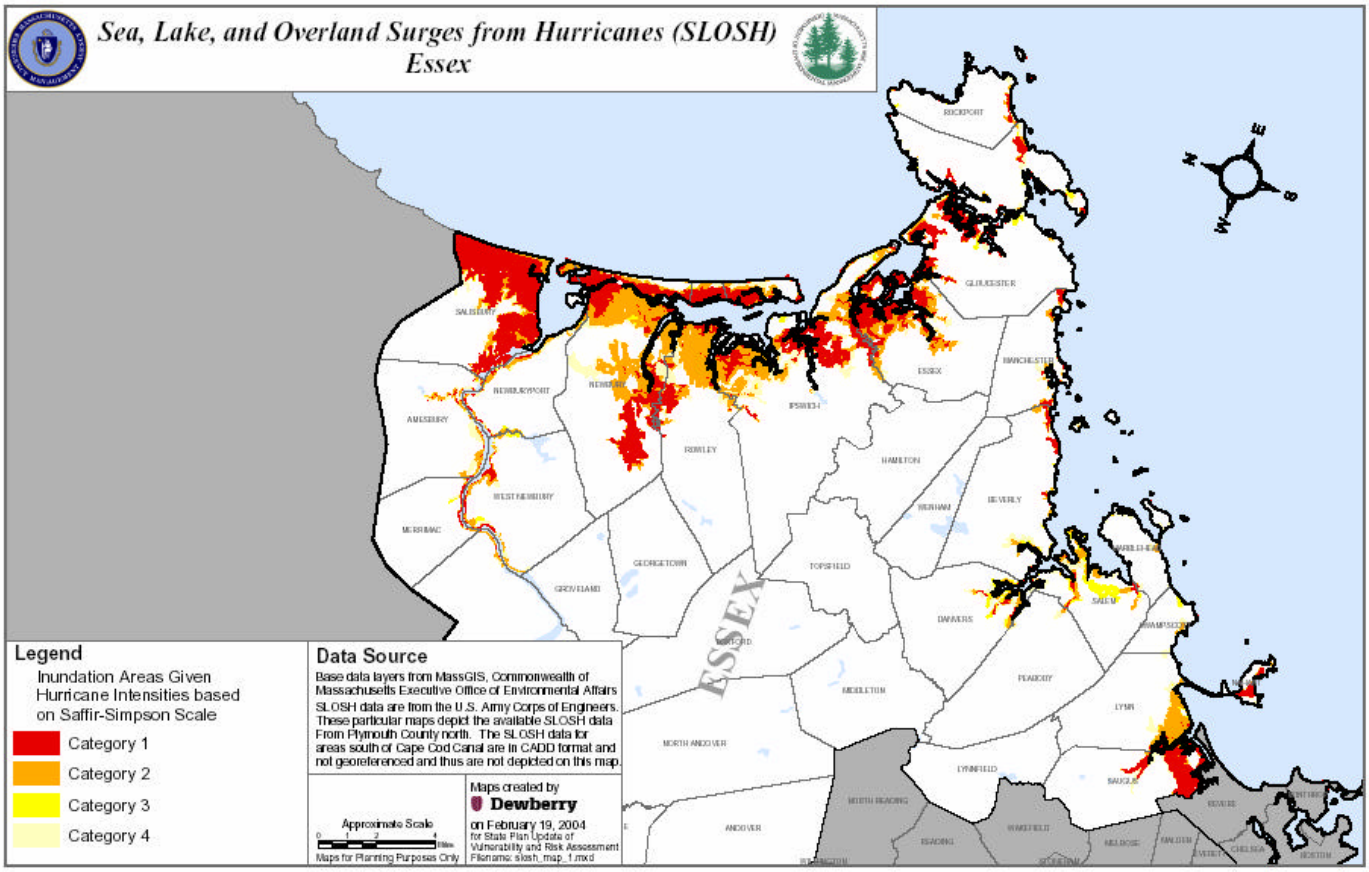
Coastal Flooding or Inundation following Hurricanes, Tropical Storms & Coastal Storms (SLOSH maps)

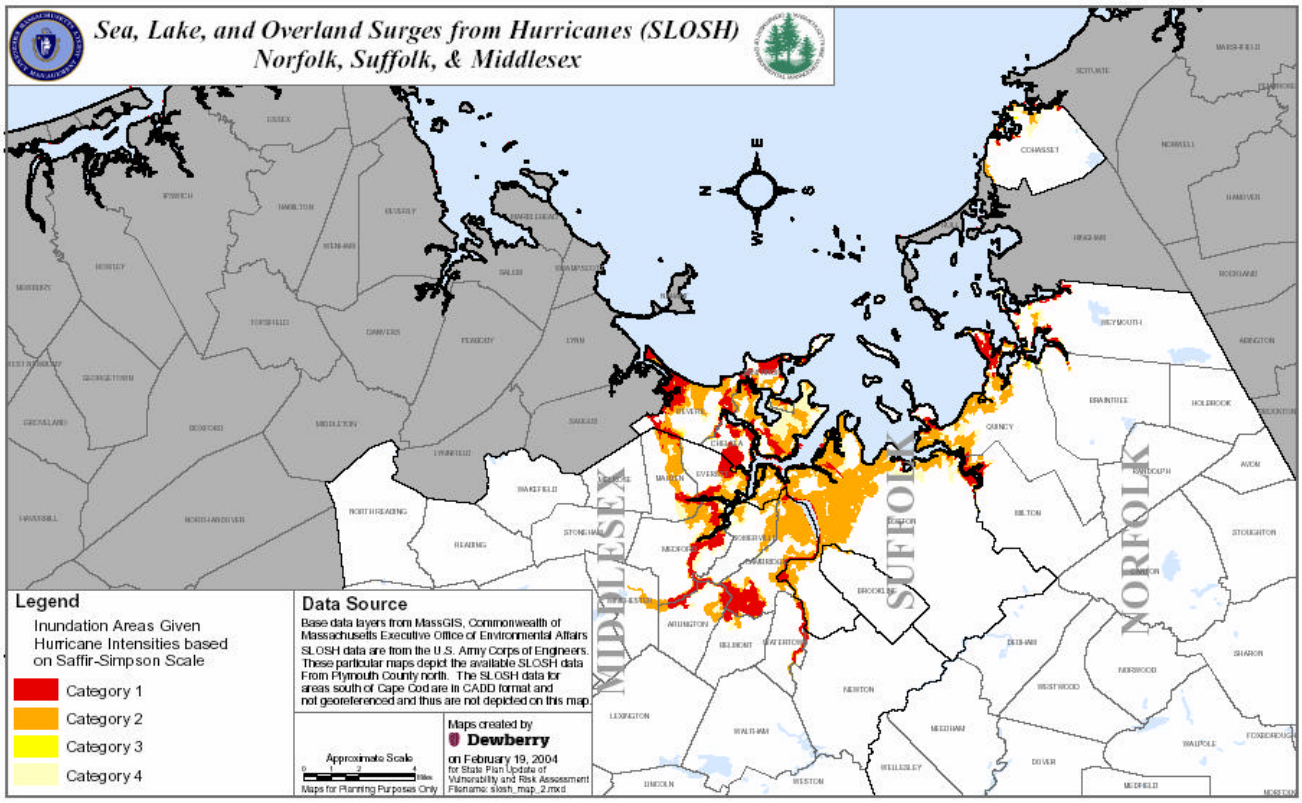
The Sea, Lake and Overland Surge from Hurricanes (SLOSH) Inundation areas maps, initially developed by the U.S. Army Corps of Engineers, depict the areas at highest risk. The U.S. Army Corps of Engineers (USACE) produced maps of SLOSH inundation areas for FEMA. The SLOSH inundation mapping for New England considers Category 1-4 hurricanes (see above) as defined by the Saffir/Simpson Hurricane Intensity Scale. The Saffir/Simpson scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential, which are combined to estimate potential damage. Wind speed is the determining factor in the scale, as storm surge values are highly

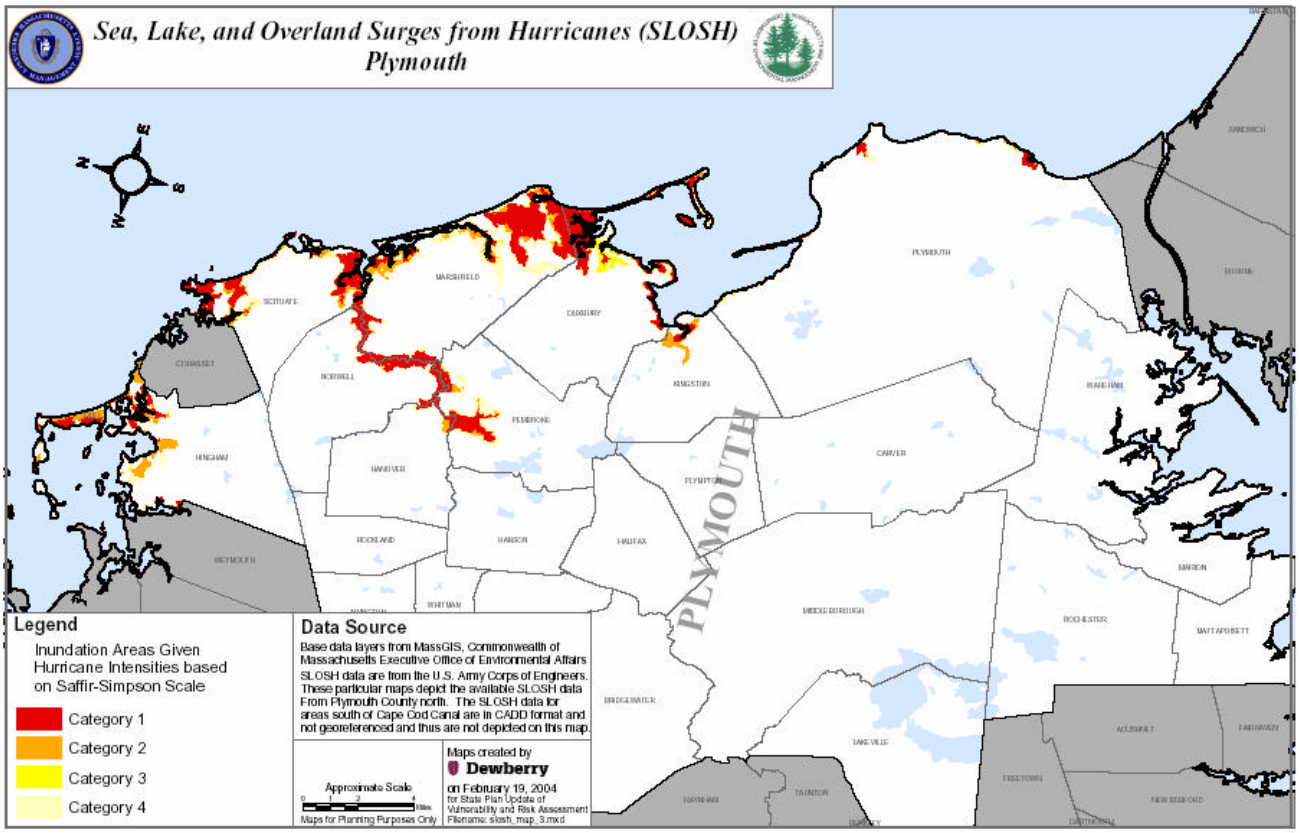
dependent on the slope of the continental shelf in the landfall region. All winds are using the U.S. 1-minute average, meaning the highest wind that is sustained for 1-minute.

USACE considered the highest wind speed for each category, the highest surge level, combined with worst case forward motion and developed a model to depict areas that would be inundated under those combined conditions for each category of storm (Category 1-3 only in New England). It should be noted that the SLOSH, MEOW considers only storm surge height and does not consider the effects of waves.

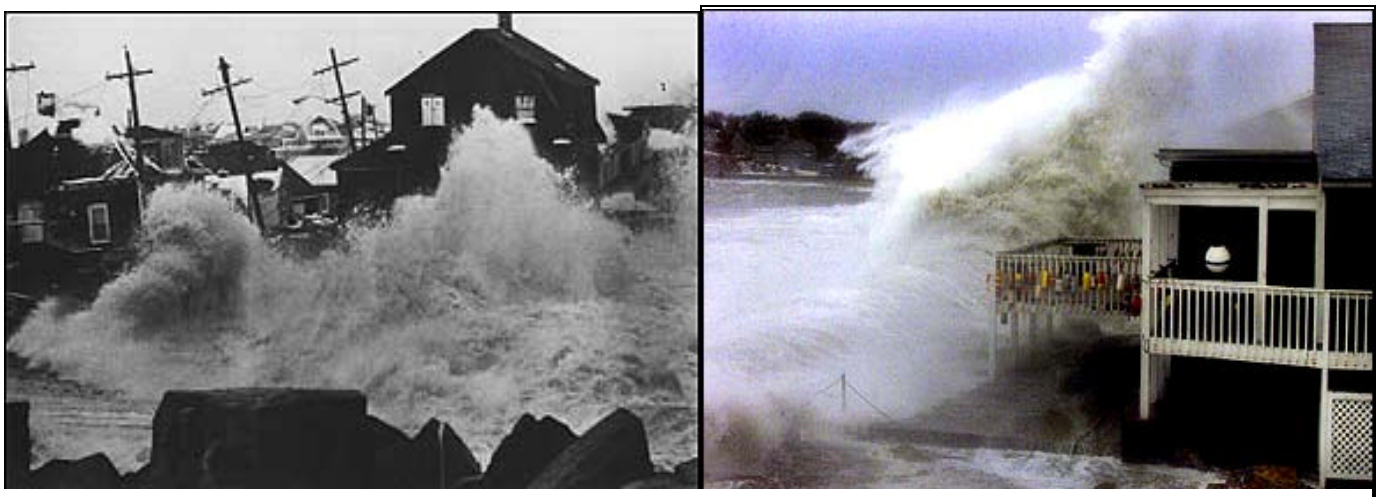
For the purpose of the State Hazard Mitigation Plan, the updated SLOSH maps split eastern Massachusetts into three sections and overlays the SLOSH inundation zones over base layers provided by MassGIS. These maps have been developed for Essex County, Norfolk, Suffolk and Middlesex Counties and Plymouth County. The state is in the process of digitizing the remaining SLOSH maps for Cape Cod and the Buzzards Bay area. Larger copies of the following maps may be found in Appendix F.







Larger versions of all the preceding maps are found in <u>Appendix F: MA Statewide Natural Hazards Maps.</u>



Coastal flooding during the Blizzard of 1978 (left) and a coastal storm in March 2001 (right)

Coastal Erosion – New Shoreline Change Data Reveal Massachusetts Coastline is Eroding

(The following text and data are from the WHOI Sea Grant Program, 2003, Marine Extension Bulletin, "New Shoreline Change Data Reveal Massachusetts is Eroding," by Jim O'Connell, WHOI Sea Grant Program and Cape Cod Cooperative Extension. A complete copy of this newsletter is located in Appendix H, New England Climatology or may be found online at www.whoi.edu/home/index_media.html)

Photo caption (Figure 1, above): Codfish Park area along the eastern shore of Nantucket. Photo courtesy of Jim Mahala. MA DEP.

Approximately 75 percent of the U.S. ocean shoreline is eroding. Massachusetts' ocean-facing shore is no exception. A recent study of shoreline change in Massachusetts by the U.S. Geological Survey, Woods Hole Oceanographic Institution Sea Grant Program, and Cape Cod Cooperative Extension reveals that approximately 68 percent, or 513 miles, of Massachusetts' ocean-facing shore exhibits a long-term erosion trend, 30 percent, or 226 miles, shows long-term accretion, and two percent, or 15 miles, shows no net change. Funding for the study was provided by the Massachusetts Office of Coastal Zone Management.

For the most part, the Massachusetts shore is eroding. For the entire ocean-facing Massachusetts shore, the long-term average annual shoreline change rate ranges between -0.58 and -0.75 feet per year. Approximately 46 percent of the Massachusetts shore is eroding at one foot or less per year, while 22 percent of the shore is accreting at one foot or less per year. Eighty-one percent of the shore fluctuates +/-2 feet per year. Based on other studies (Pilkey & Thieler, 1992), 75 percent of the U.S. ocean shore is eroding, with the U.S. East Coast eroding at an average rate of 2-3 feet per year (Leatherman, 1993). Thus, Massachusetts' average annual shoreline change rate is lower than the East Coast average. That statistic is of little comfort for shorefront property owners in the Commonwealth, where rates of shoreline change vary considerably along the shore with some areas eroding between 7-10 feet per year (Figure 1, above), and higher.

Long-term rates of shoreline change calculated for each of the 15 Cape Cod communities and the islands of Martha's Vineyard and Nantucket reflect this shoreline change variability (Figure 2, right). It is important to note that rates also vary considerably within communities.

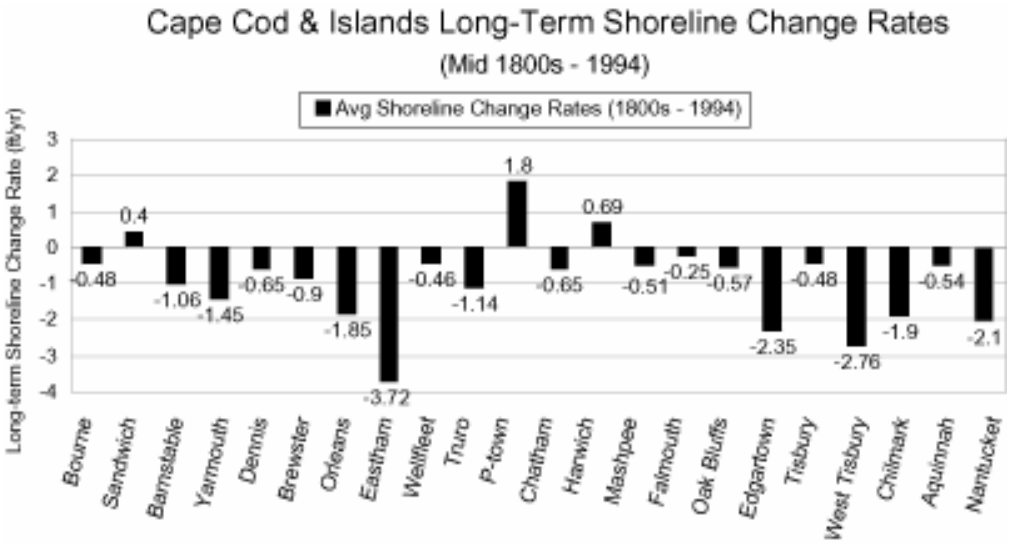
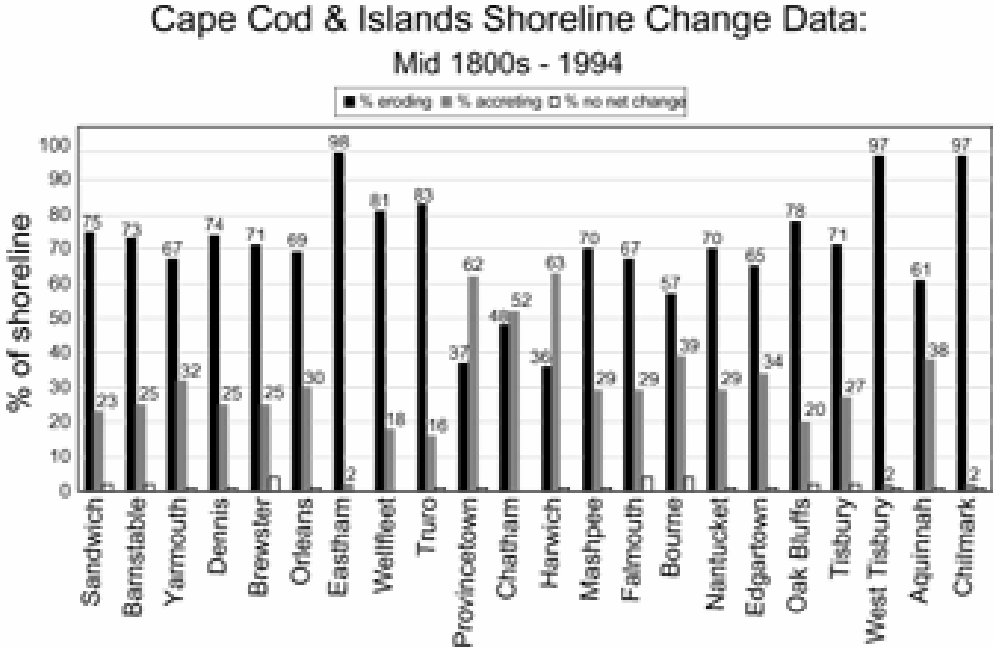


Figure 3, below, shows the status of shoreline change for Cape Cod, Nantucket and Martha's Vineyard communities. Note that eroding transects predominate in most communities. The highest rates of erosion and the longer expanses of eroding shoreline within a community are generally located along high-wave energy, open-ocean shores. For example, the Eastham shore exhibits the highest number of eroding transects at 98 percent (2 percent accreting), followed by Truro at 83 percent eroding, (16 percent accreting), and Wellfleet at 81 percent eroding, (18 percent accreting). These communities are exposed to both predominant wind and waves from the northeast and prevailing winds and waves from the west. Other communities have less severe erosion problems, such as Falmouth at 67 percent eroding (29 percent accreting) and Mashpee at 69 percent eroding (30 percent accreting), due to the sheltering effects from ocean storm waves by the islands of Martha's Vineyard and Nantucket.



Only three Cape Cod communities have a greater number of accreting transect locations than eroding transects, including Harwich at 63 percent accreting (36 percent eroding), which is protected from ocean storm waves by Monomoy Island. Also Provincetown at 62 percent accreting (37 percent eroding), which receives a large volume of sand from the eroding Cape Cod National Seashore bluffs.

A number of factors determine whether a community exhibits greater long-term erosion or accretion:

- exposure to high-energy storm waves,
- sediment size and composition of eroding coastal landforms feeding adjacent beaches,

- near-shore bathymetric variations which direct wave approach,
- alongshore variations in wave energy and sediment transport rates,
- relative sea level rise, and
- human interference with sediment supply (e.g. revetments, seawalls, jetties).

Interpreting Shoreline Change Data: Proceed with Caution! - A word of caution when reading long-term shoreline change rates: ***always*** analyze the short-term data that were used to calculate the long-term shoreline change rate. If short-term trend reversals in shoreline change have occurred (accretion to erosion or vice versa), it may be more appropriate to use the most recent short-term shoreline change rate than the long-term rate for siting a structure or for planning purposes.

For example, transects along the Codfish Park area of Nantucket's eastern shore show a long-term accretion rate of approximately +1.5 feet per year. However, the shoreline has been eroding since the 1950s, and erosion has accelerated since 1978 to 7-10 feet per year (Figure 1, above). The long period of accretion that took place from the mid-1800s to the 1950s biases the long-term rate, making the data suggest that the area is stable or accreting. The trend reversal and continuing erosion since the 1950s, however, illustrates the importance of analyzing short-term data and its potential utility in determining present-day construction setbacks and for planning purposes.

The widespread construction of coastal engineering structures, such as revetments, seawalls, jetties and groins -- particularly since the 1940s and 1950s -- has also affected shoreline change rates. In many areas, these coastal engineering structures have contributed to a trend reversal or accelerated down drift erosion rates, and therefore their effects must be factored into analyzing long-term shoreline rates. The northern area of Humarock Beach in Scituate is a case in point, where erosion rates have accelerated in recent years due to both natural and human effects. The shoreline area east of Sandwich Harbor in Sandwich shows erosion has accelerated due, in part, to the effects of jetties.

Human activity, however, is not the sole reason for trend reversals and shoreline changes. In some areas, such as the southeastern shore of Nantucket, natural processes are responsible for large trend reversals (accretion to erosion back to accretion to erosion) over the 150-year study period. In this area, the data reveal that the shoreline has fluctuated between 50 to 100 feet of both erosion and accretion resulting in a long-term average suggesting stability. The shoreline is, however, exceptionally variable.

Ongoing Shoreline Change Analyses - WHOI Sea Grant and Cape Cod Cooperative Extension, plus the MA Office of Coastal Zone Management, the U.S. Geological Survey and other agencies are conducting a detailed analysis of the recent shoreline change data to better understand why some areas are eroding and others accreting. They are also documenting areas where the use of short-term data may be more appropriate than long-term rates for planning and safe set-backs of buildings and other structures. The shoreline change maps and data can be viewed on the Massachusetts CZM web site (http://www.state.ma.us/czm/czm.htm).

MA Hazard Mitigation Success Story

Quincy's Hollis Avenue Drainage Project Prevents Flooding

The City of Quincy has 27 miles of coastline and 15 miles of tidal shoreline with about 3 square miles in a designated 100-year floodplain. Many homes were built more than 50 years ago, with little or no regard to potential flooding. In the last 10 years, more than 150 residential properties have reported repetitive flood damage as a result of serious rainfalls or snowstorms. Certain neighborhoods are subject to flooding during hurricanes, tropical rainstorms and surges. The city is also affected by overflows from Furnace Brook, Town Brook, the Neponset River and wetlands areas.

The Hollis Avenue Drainage Project was designed to prevent chronic flooding in a low-lying area adjacent to the coast. The project affects approximately 45 houses. Quincy Shore Drive is at a higher elevation than the neighborhood and acts as a dike, since it is the only geographic feature separating the area from the Atlantic Ocean.

To solve the problem, the city wanted to construct a pump station and replace drain lines. The pumping station was designed not to run constantly, but to be triggered during intense storms or high tides just before the area floods. It was completed at a cost of $1.2 million, of which $500,000 came from FEMA's Hazard Mitigation Grant Program. The first test came with the March 2001 flooding.

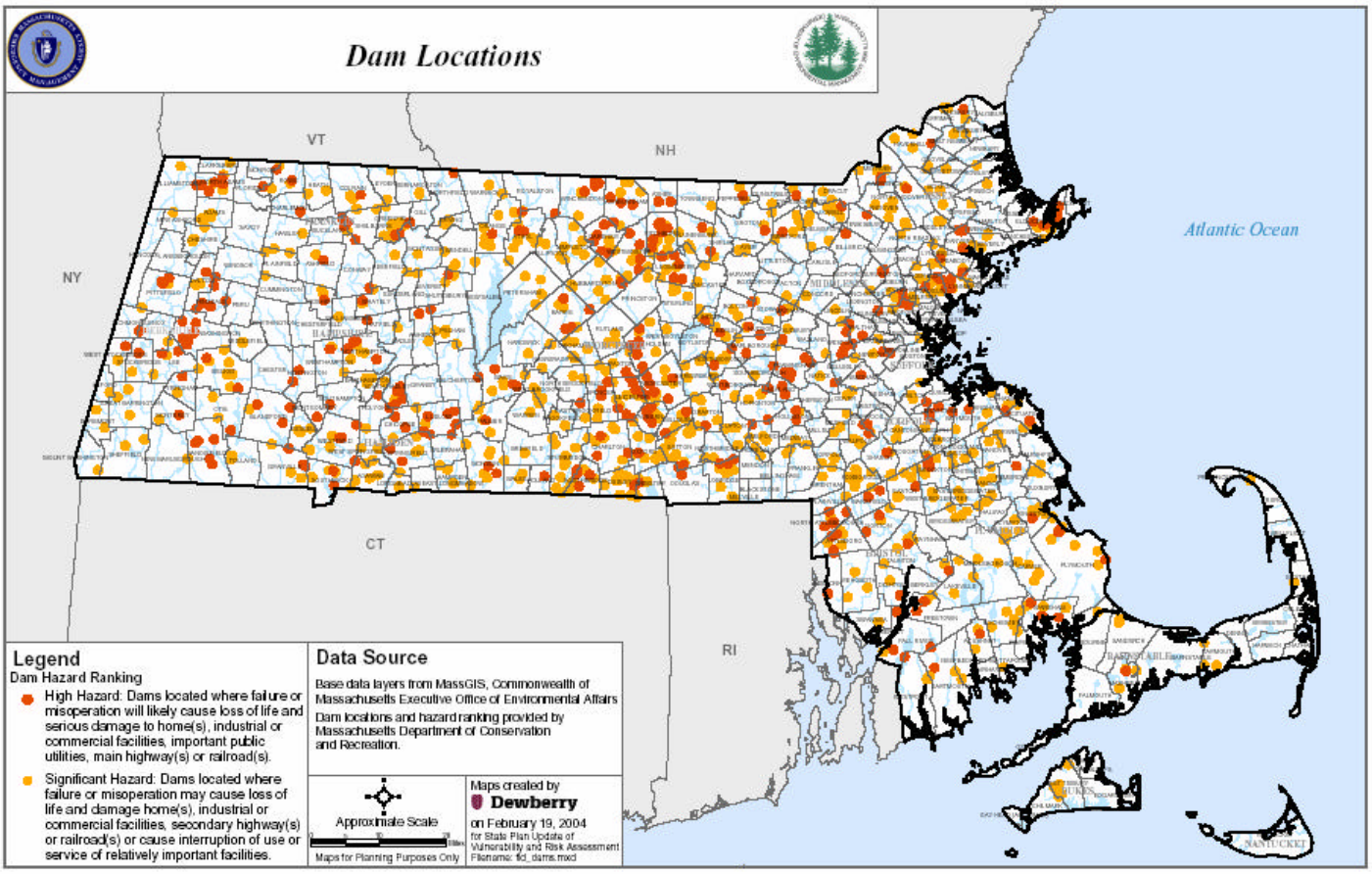
"Everything worked perfectly. It was a tremendous success. It functioned as it should have. The neighborhood was much relieved," said Richard H. Meade, planning director for the City of Quincy. Quincy's preventive measures to moderate the effect of future coastal and riverine flooding include: constructing and rebuilding seawalls; retrofitting houses; acquisition and demolition; drainage and public works improvement. Quincy's retrofitting program, begun in 1993 with FEMA support, has provided funding for the elevation and/or relocation of heating systems, electric panels, water heaters and appliances above the base flood elevation.

Additional funding for this project was provided Community Development Block Grant funds from the U.S. Department of Housing and Urban Development and administered by MEMA and DCR.

Location of High & Significant Hazard Dams

A map of dam locations of state-owned and federal-owned high and moderate hazard dams (as defined by Massachusetts regulation and federal stature) depicts shaded points over Massachusetts municipal and hydrology layers (see Appendix X). The majority of these dams are located within the floodplain.

The Massachusetts Office of Dam Safety, under the Department of Conservation and Recreation (DCR), maintains a database of all the publicly and privately owned dams in the Commonwealth. This database includes all high hazard, significant hazard and low hazard dams. This information includes all the high hazards dams currently listed the National Dam Inventory which is has been developed as part of the National Dam Safety Program under the U.S. Army Corps of Engineers (per Public Law 92-367).



Index of Environmental Risk at Dams

The Massachusetts Department of Fisheries and Wildlife's Riverways program, under its River Restore Program, is in the process of developing a draft GIS-based analytical framework, the **Index of Environmental Risk at Dams**, to: (1) assess the environmental impact of dams on aquatic resources from their contributions to environmental degradation, and (2) characterize the environmental hazard to aquatic and other public resources from the uncontrolled breach or catastrophic failure of dams.

Developing a viable Index of Environmental Risk will focus scarce public dollars on necessary and environmentally appropriate dam repair and dam removal projects and will provide the baseline information necessary for individual dam owners, municipalities, and grassroots conservation organizations to address the status of dams in their watershed communities.

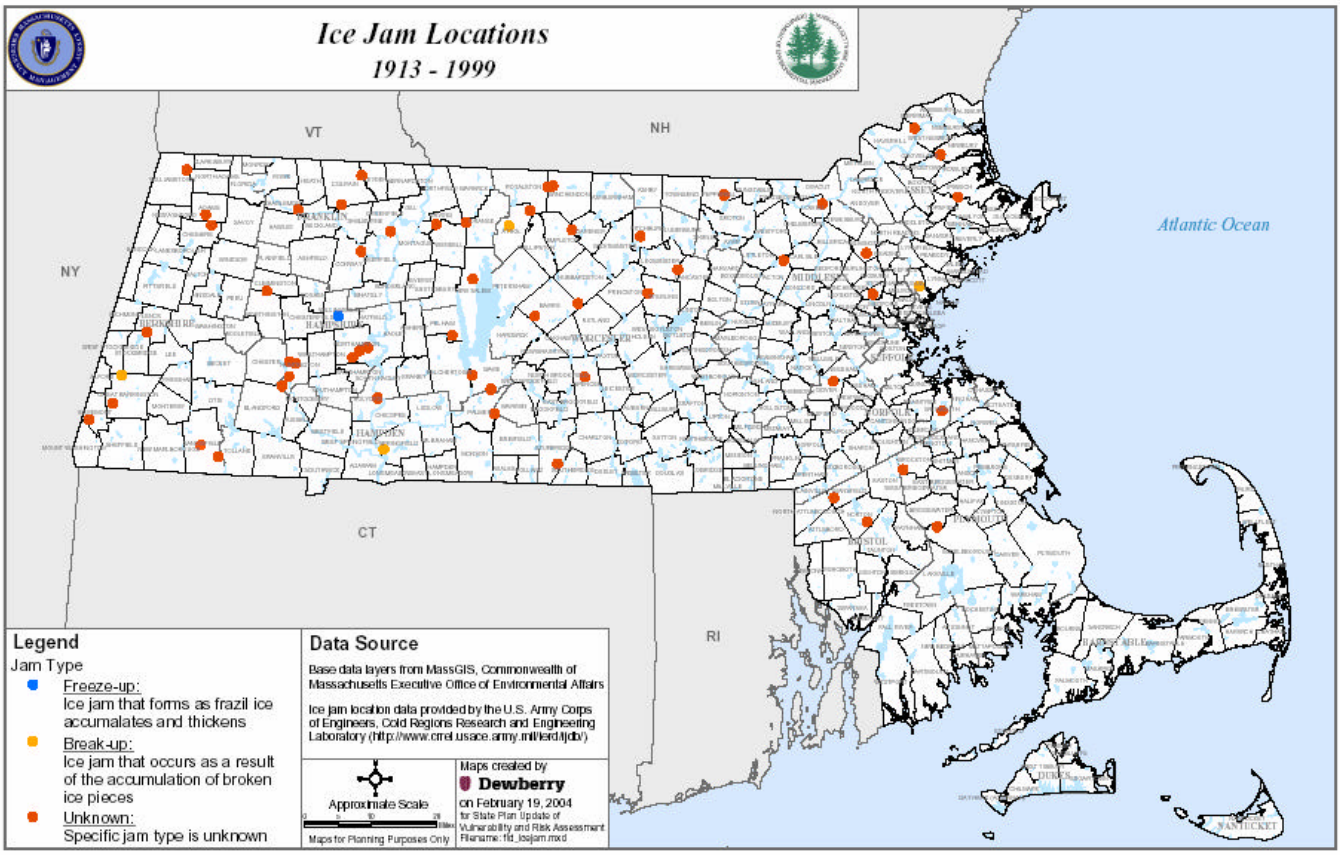
Regarding environmental hazard, the Riverways River Restore Program has explored two potential sources of natural resource impacts that may result from catastrophic dam failure: release of contaminants from either behind the dam (impounded sediment) or in the inundation zone downstream (land uses), and/or damage to sensitive aquatic species or habitats downstream due to the release of high velocity waters and/or uncontaminated sediment. Due to the paucity of site-specific sediment quality data, the Riverways River Restore Program has adapted a model developed by the University of Massachusetts for the Natural Heritage and Endangered Species Program called AQUALAND to predict the likelihood that sediment impounded behind dams are to be contaminated. The model integrates current contaminant loading, fine-grained sediment loading, and the sediment-trapping efficiency of dams. In 2004, this program will be testing how

robust the Index acts as a predictive tool for identifying and prioritizing opportunities to restore and protect aquatic habitats. In particular, this program will be collaborating with The Nature Conservancy as well as Department of Fish and Game biologists to evaluate the environmental impact metrics. Riverways has also contracted with the U.S. Geological Survey to test the predictive model associated with environmental hazard.[xxxv]

Ice Jam Locations 1913 – 1999

This map is included under the flood section of this plan because one of the major hazards from ice jams has been flooding. A more detailed description of this map may be found under "Winter Weather" on page X. The information on past ice jam locations in Massachusetts was obtained from Kathleen D. White, PhD, PE, Associate Technical Director, U.S. Army Corp of Engineers Cold Region Research and Engineering Laboratory (CRREL) database. According to CRREL, documentation on ice jams and other ice jam events in the United States is not easily obtained despite the fact that much information has been collected and compiled for open-water flood events. The lack of information on ice events is due in part to the fact that most ice events occur even less frequently than open water floods, but also because ice events are often short-lived and may affect only a short reach of river.

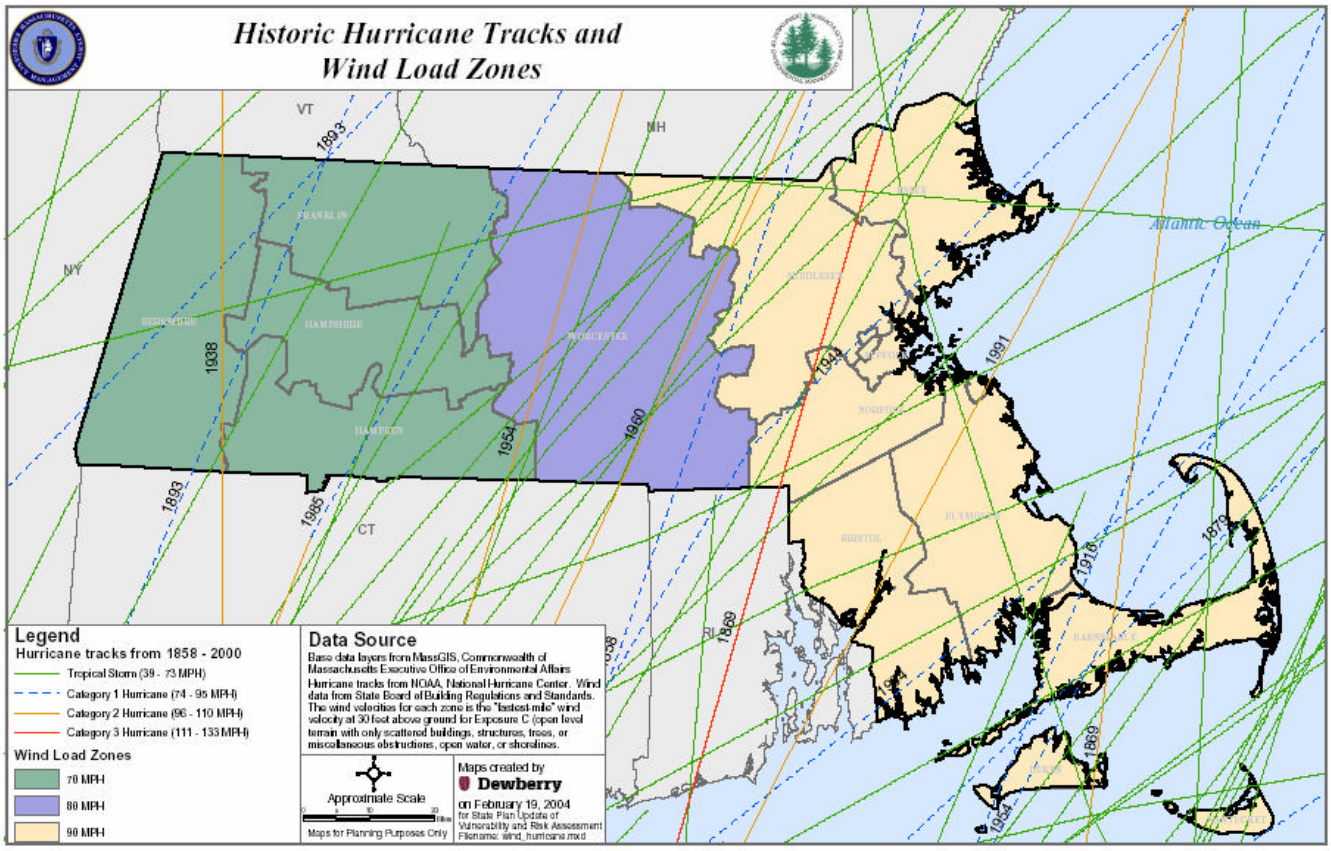
According to Dr. White, the Ice Jam Database only uses specific types when CRREL knows for sure that the jam was breakup or freeze-up, otherwise it is listed as unknown. While going by date, which is included in the table, is not enough to discern the difference in type, although generally late spring dates are break-up jams. A document further describing the Ice Jam Database can be found at CRREL's website at: http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/CR99_02.pdf



Areas Vulnerable to Wind-Related Hazards

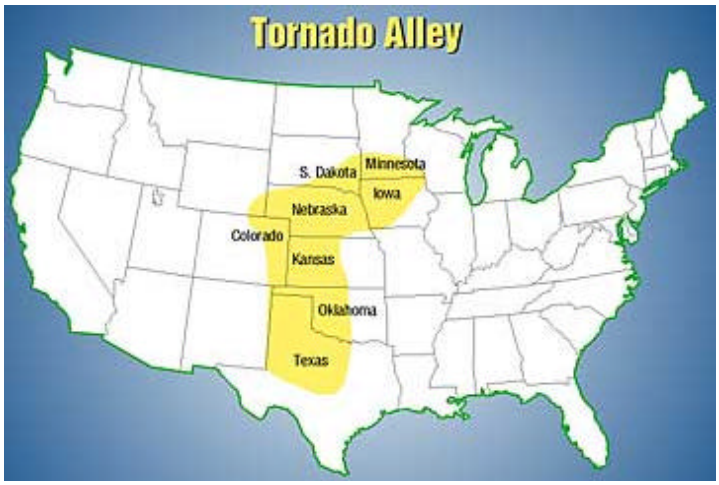
Hurricanes and Tropical Storms - The following map of **Historic Hurricane Tracks and Wind Load Zones** gives an overview of the many storms with high winds that have impacted Massachusetts over the last 100 years. A larger version of this map may be found in Appendix F. In addition, the previous SLOSH maps give additional information on the coastal areas impacted by hurricanes, tropical storms and coastal storms based on the number of recorded event

Areas at Risk: The entire state is vulnerable to hurricanes and tropical storms, dependent on the storm's track (see following map with a larger version in Appendix F). The coastal areas are more susceptible due to the deadly combination of both high winds and tidal surge, as depicted on the SLOSH maps. Inland areas, especially those in floodplains, are also at risk for flooding and wind damage. The majority of damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was recently demonstrated during Hurricane Floyd in 1999.

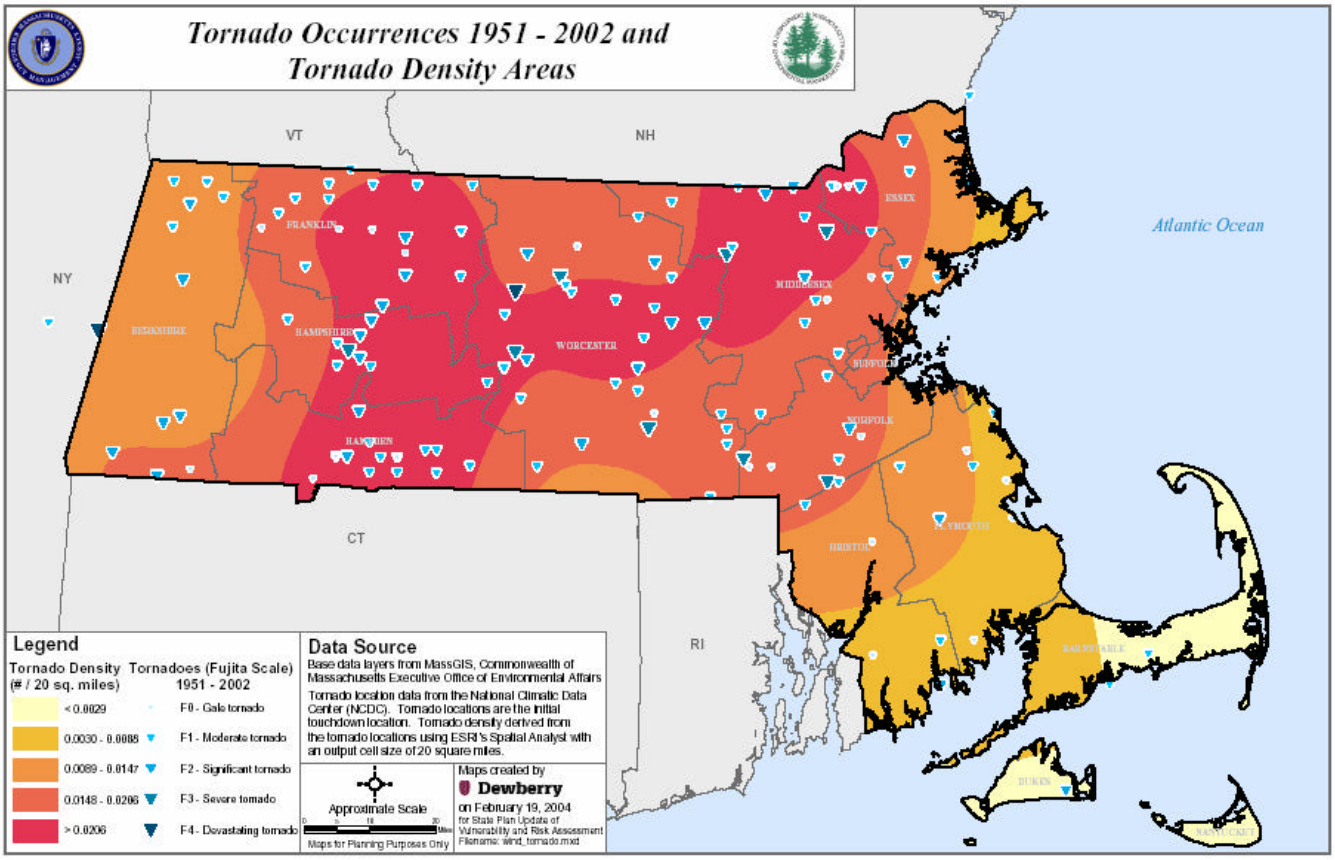


Tornadoes – It is a given that weather forecasters know that tornadoes can and do happen any time of the year in just about any location. Through years of study by the National Severe Storms Laboratory, it is has been determined that there are areas of the United States that are more prone to strong and violent tornadoes.

According to the National Severe Storms Laboratory, tornadoes occur most often in the central United States, commonly known as Tornado Alley. This area has a consistent season every year from April through mid-June, with the most tornadoes occurring in May. Second, the central plains have a repeatable annual tornado cycle, with the highest probability of tornado occurrence in the springtime. Finally, areas outside of tornado alley do not have a typical tornado season and experience fewer tornadoes. (Source: National Severe Storms Laboratory website, http://www.nssl.noaa.gov/hazard , 2004).



Massachusetts obviously doesn't fall in Tornado Alley; however, tornadoes do occur in but not during a particular time or year or in a particular area. Unfortunately, the previous saying of "tornados can and do occur anytime, anywhere" applies to Massachusetts (and the rest of New England). This situation may be more dangerous than states in Tornado Alley because Massachusetts residents don't expect severe tornados and history proves otherwise.

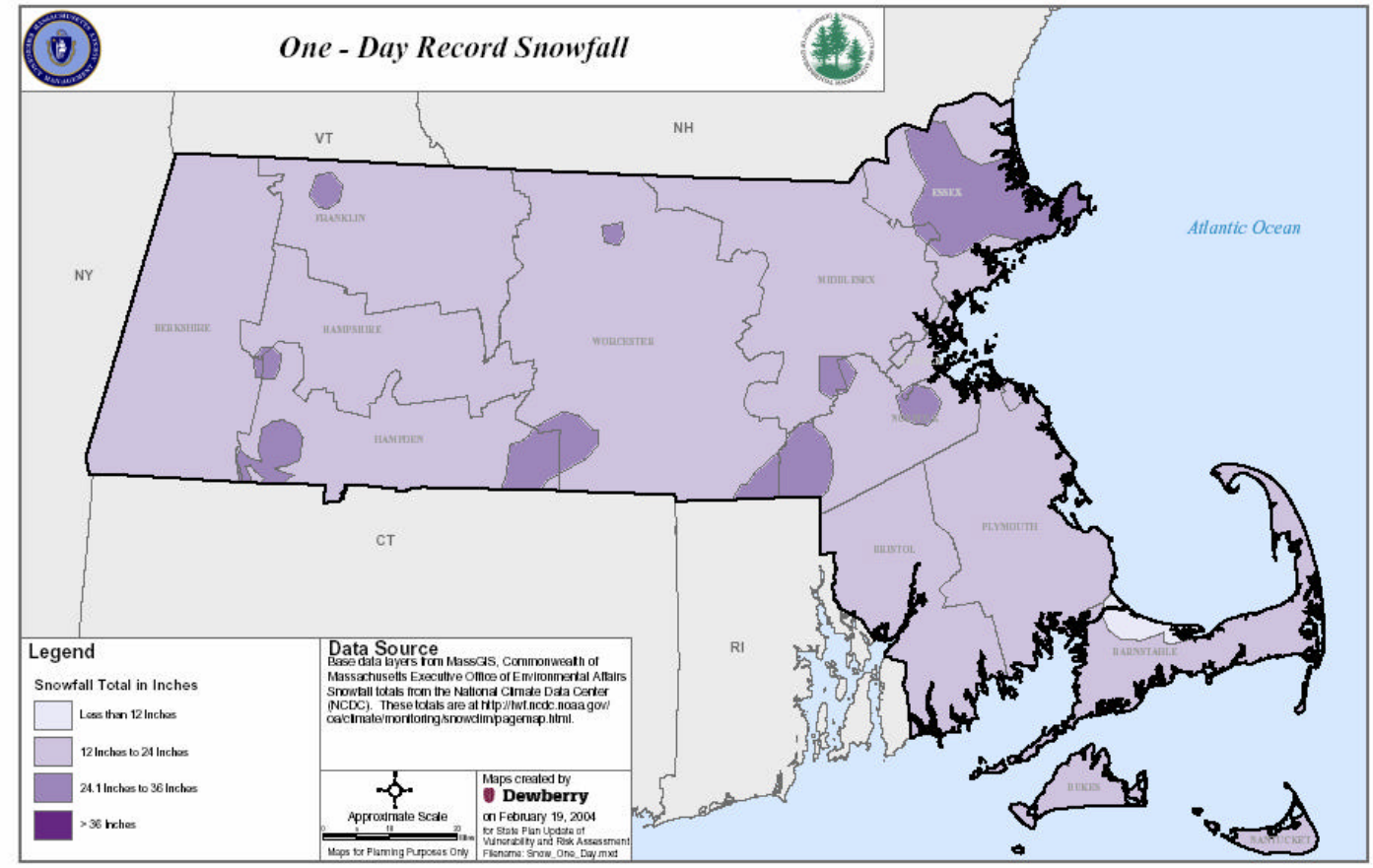


The above map depicts point locations of initial tornado touch down locations for the period of record using graduated symbols. These symbols depict tornado intensity based on the Fujita Scale with thematically shaded tornado density zones derived through Arc view Spatial Analyst software and recorded tornado touchdown locations. These touchdown locations, obtained from NOAA, are based on a search radius of 50,000 square miles and the density of historical tornados translated to any given 20 square mile area. The density per 20 square miles in the map's legend indicates the probable number of tornadoes for each 20 square mile cell within the contoured zone that can be expected over a similar period of record (51 years). It should be noted that the density number does NOT indicate the number of events that can be expected across the entire zone on the map.

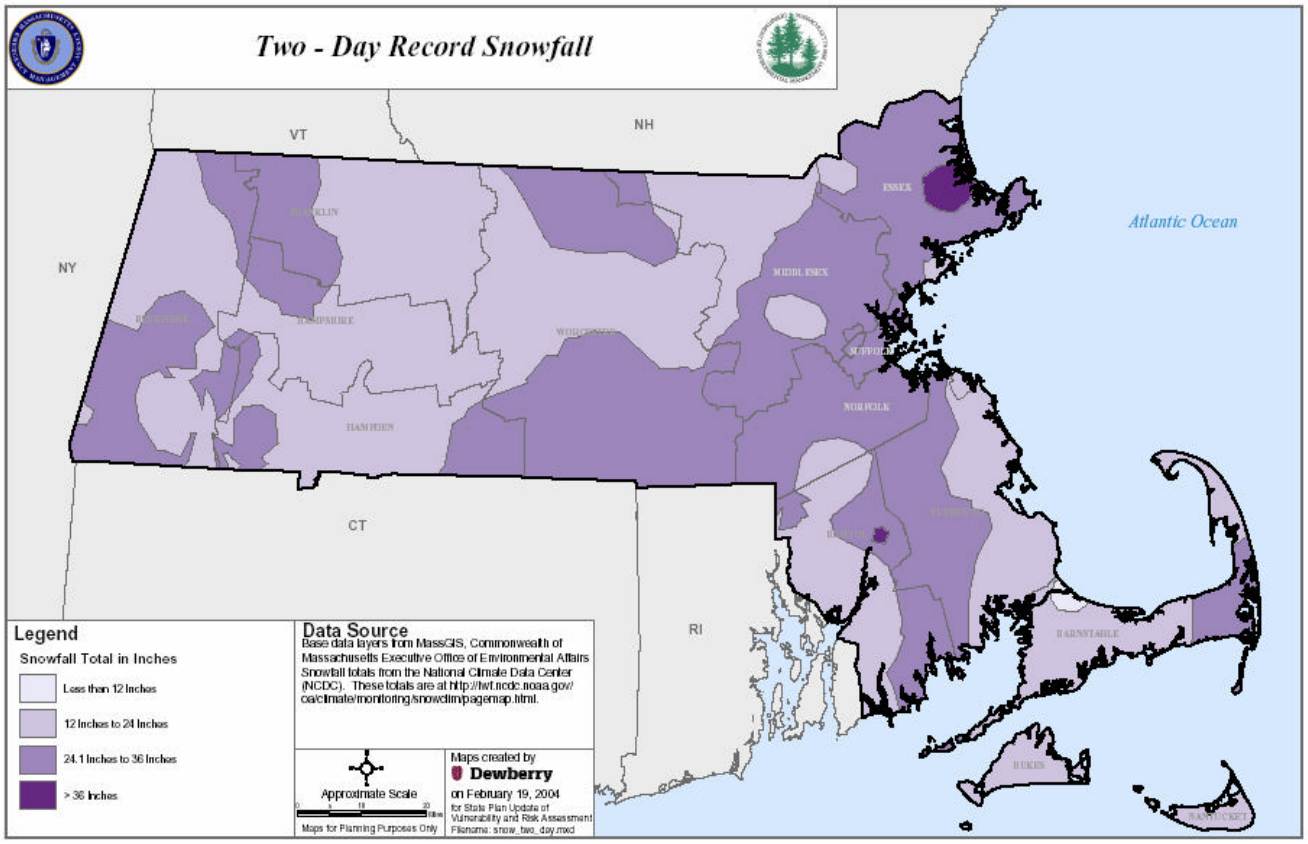
Areas at Risk: A tornado may happen any where in Massachusetts given the right climatic conditions. Based on past events, as depicted in the above map and the map's methodology, it appears that the area at greatest risk for a tornado touchdown runs from central to northeastern Massachusetts**.**

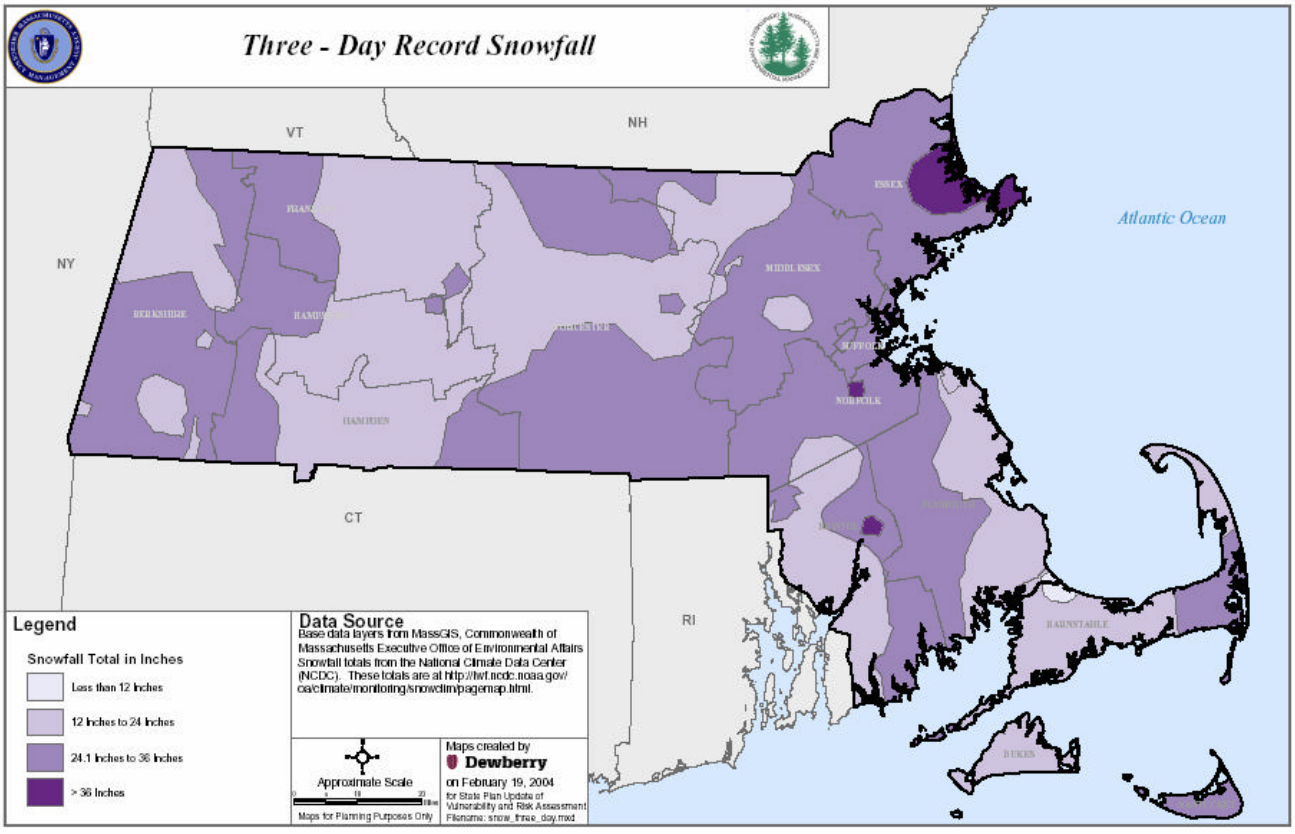
Areas Vulnerable to Winter-Related Hazards

Snowstorms - The following maps of 1-day, 2-day, and 3-day record snowfall were developed using information collected from NOAA's National Climatic Data Center (NCDC). A total of 99 stations in Massachusetts were selected from NCDC's database as having reliable, long-term snowfall records suitable for this analysis. The 1-day, 2-day, and 3-day record snowfall from the 99 reliable stations were utilized to develop a statewide snowfall distribution, using a process known as "Inverse Distance Weighted" (IDW). IDW estimates cell values by averaging the values of sample data points in the vicinity of each cell, applying greater weight to those data points closer to the cell. A more detailed description of IDW and the mapping process used is contained in the Dewberry report in Appendix G.



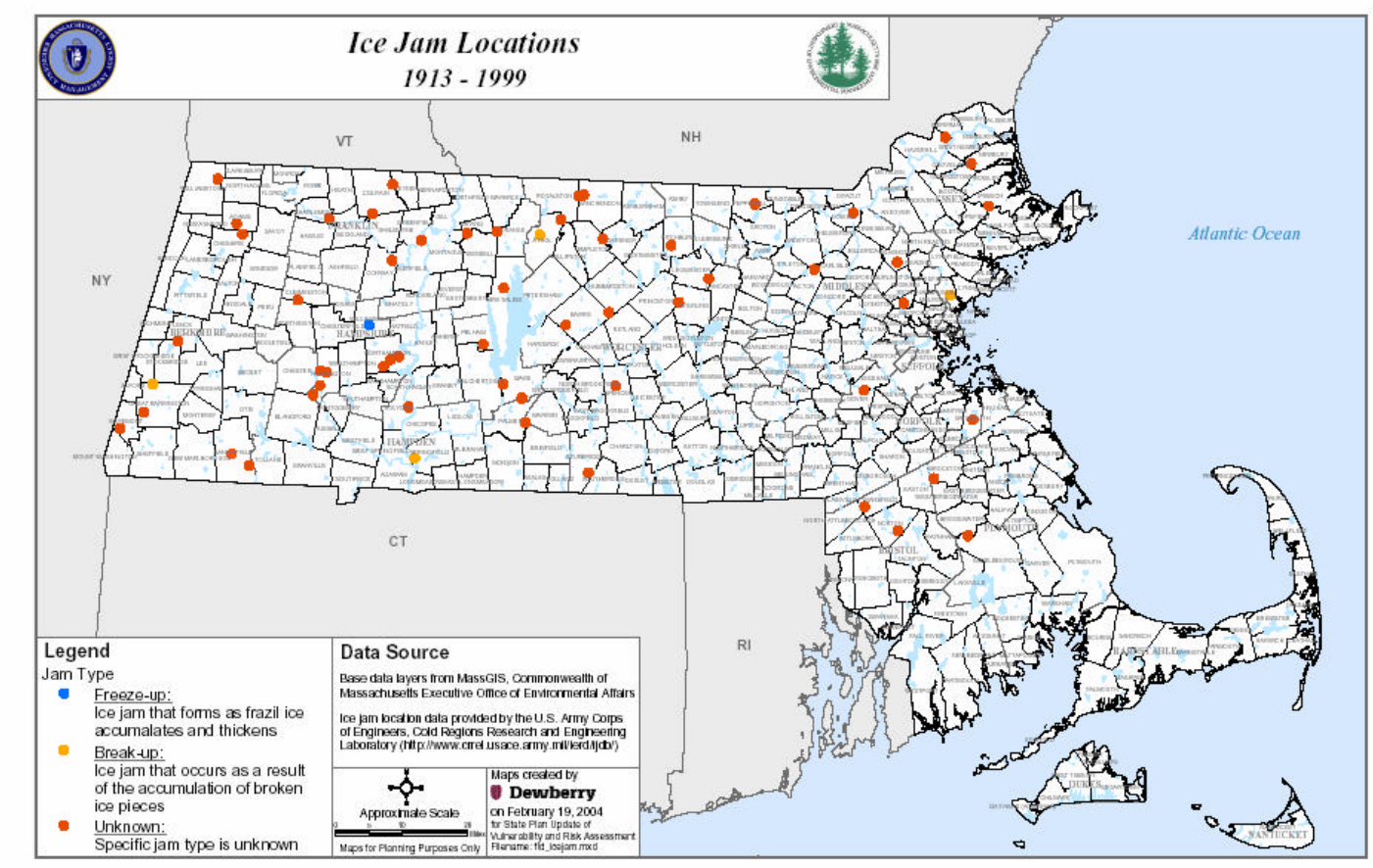
Larger versions of these maps may be found in Appendix F.


Two - Day Record Snowfall
VT
NH
NY
CT
RI
Atlantic Ocean
ESSEX
MIDDLESEX
NORFOLK
HAMPDEN
HAMPSHIRE
BERKSHIRE
BARNSTABLE
DUKES
Legend
Snowfall Total in Inches
Less than 12 Inches
12 Inches to 24 Inches
24.1 Inches to 36 Inches
> 36 Inches
Data Source
Base data layers from MassGIS, Commonwealth of Massachusetts Executive Office of Environmental Affairs
Snowfall totals from the National Climate Data Center (NCDC). These totals are at http://lwf.ncdc.noaa.gov/oa/climate/monitoring/snowclim/pagemap.html.
Approximate Scale
Maps for Planning Purposes Only
Maps created by
Dewberry
on February 19, 2004
for State Plan Update of Vulnerability and Risk Assessment
Filename: snow_two_day.mxd


Three - Day Record Snowfall
VT
NH
NY
CT
RI
Atlantic Ocean
ESSEX
MIDDLESEX
NORFOLK
HAMPDEN
BERKSHIRE
BARNSTABLE
DUKES
Legend
Snowfall Total in Inches
Less than 12 Inches
12 Inches to 24 Inches
24.1 Inches to 36 Inches
> 36 Inches
Data Source
Base data layers from MassGIS, Commonwealth of Massachusetts Executive Office of Environmental Affairs
Snowfall totals from the National Climate Data Center (NCDC). These totals are at http://lwf.ncdc.noaa.gov/oa/climate/monitoring/snowclim/pagemap.html.
Approximate Scale
Maps for Planning Purposes Only
Maps created by
Dewberry
on February 19, 2004
for State Plan Update of Vulnerability and Risk Assessment
Filename: snow_three_day.mxd

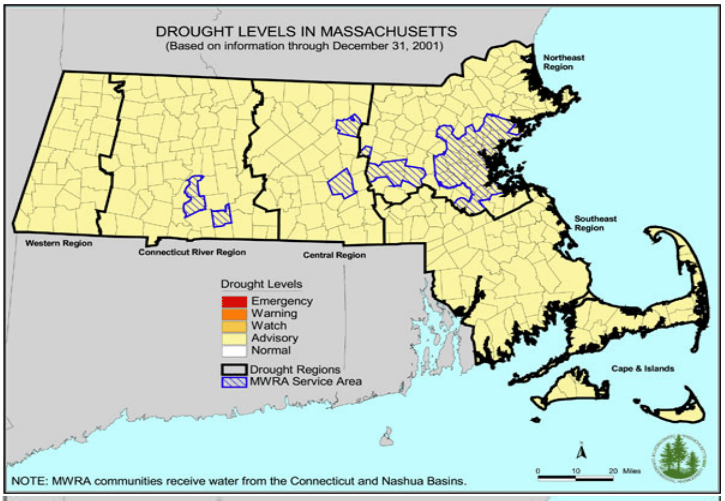
Areas at Risk: Although the entire state may be considered at risk (no community in Massachusetts escapes winter!), higher snow accumulations appear to be prevalent at higher elevations in Western and Central Massachusetts, and along the coast where snowfall can be enhanced by additional ocean moisture. The coastline is susceptible to the deadly combination of both snow and coastal flooding during a northeaster.

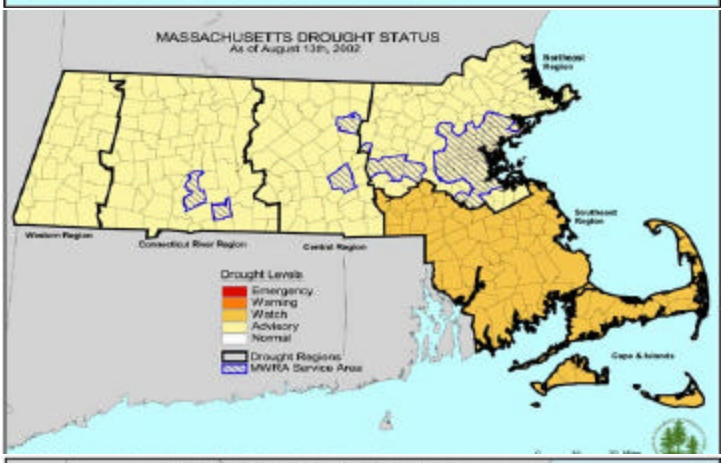
Ice Jam Locations – The following information on ice jam types, and jam causes and possible solutions in Massachusetts was obtained from Kathleen D. White, PhD, PE, Associate Technical Director, U.S. Army Corp of Engineers Cold Region Research and Engineering Laboratory (CRREL) database. Ice events can include ice jams, ice jams that are not identified as such, the formation of an ice cover which raises water levels upstream or decreases water levels downstream, or any other result of ice formation, ice cover formation and progression, or ice cover breakup. For more detailed information on ice jams in New England, go to the CRREL website at http://www.crrel.usace.army.mil/ierd/icejam/icejam.htm#intro

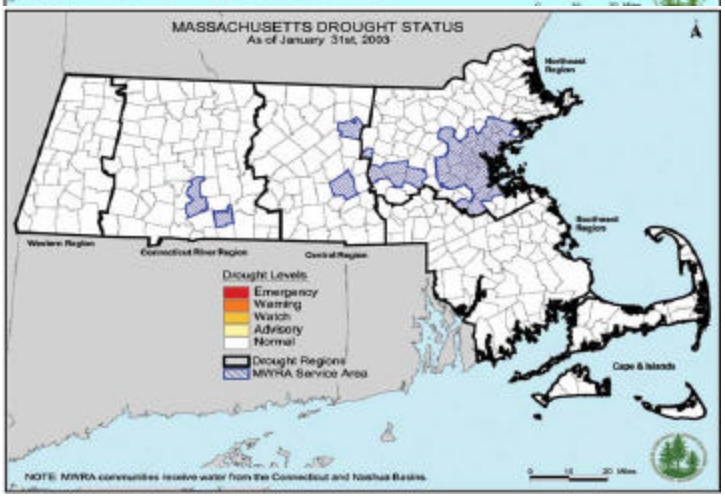


Areas at Risk: Ice jams may occur in any of Massachusetts streams, rivers and ponds, given the appropriate winter weather conditions. This map indicates that, based on past winters, ice jams appear to occur more frequently in the central and western part of Massachusetts.

Areas Vulnerable to Fire-Related Hazards







Drought - A recent drought period in Massachusetts began in the spring and summer of 1999. In some areas of the state, cumulative deficits in precipitation reached 8 to 12 inches below normal over a 12-month period. Stream flows across much of the state routinely fell below the 25th percentile of their historical flows for the month (within the lowest 25 percent on record for the month), and many with long periods of record set record low stream flow levels.

Ground water levels were also below normal throughout the summer over almost the entire state Precipitation remained below normal for the period from April, 1999 to March, 2000. While the summer of 2000 provided relief from these dry conditions, it is worth noting that the conditions in the first few months of the year were slightly worse than the early years of the drought of record experienced during the 1960s.[xxxvi]

State and federal agencies met during this dry period of 1999 at the Massachusetts Emergency Management Agency Operations Center in Framingham as an ad-hoc Drought Management Task Force. The task force consisted of officials from state and federal agencies as well as certain professional organizations that have responsibility for areas likely to be affected by drought conditions as well as agencies that provide data related to assessing the severity of drought conditions, such as the United States Geologic Survey (USGS), National Weather Service (NWS), and other public health and safety professionals. From this group, a Massachusetts Drought Management Plan was developed.

As part of this statewide drought management plan, data provided by the respective agencies is compiled into the "Current Conditions Report," a report summarizing current water resource conditions that is prepared on a monthly basis by the Department of Conservation and Recreation (DCR) for the Water Resources Commission (WRC). This report, which has been produced since June 1999, includes ground water data, surface water data, reservoir data, precipitation data, and streamflow conditions as well as reports on fire danger and agricultural conditions. These precipitation reports and maps may be found on the internet at http://www.state.ma.us/dem/programs/rainfall/drought.htm.

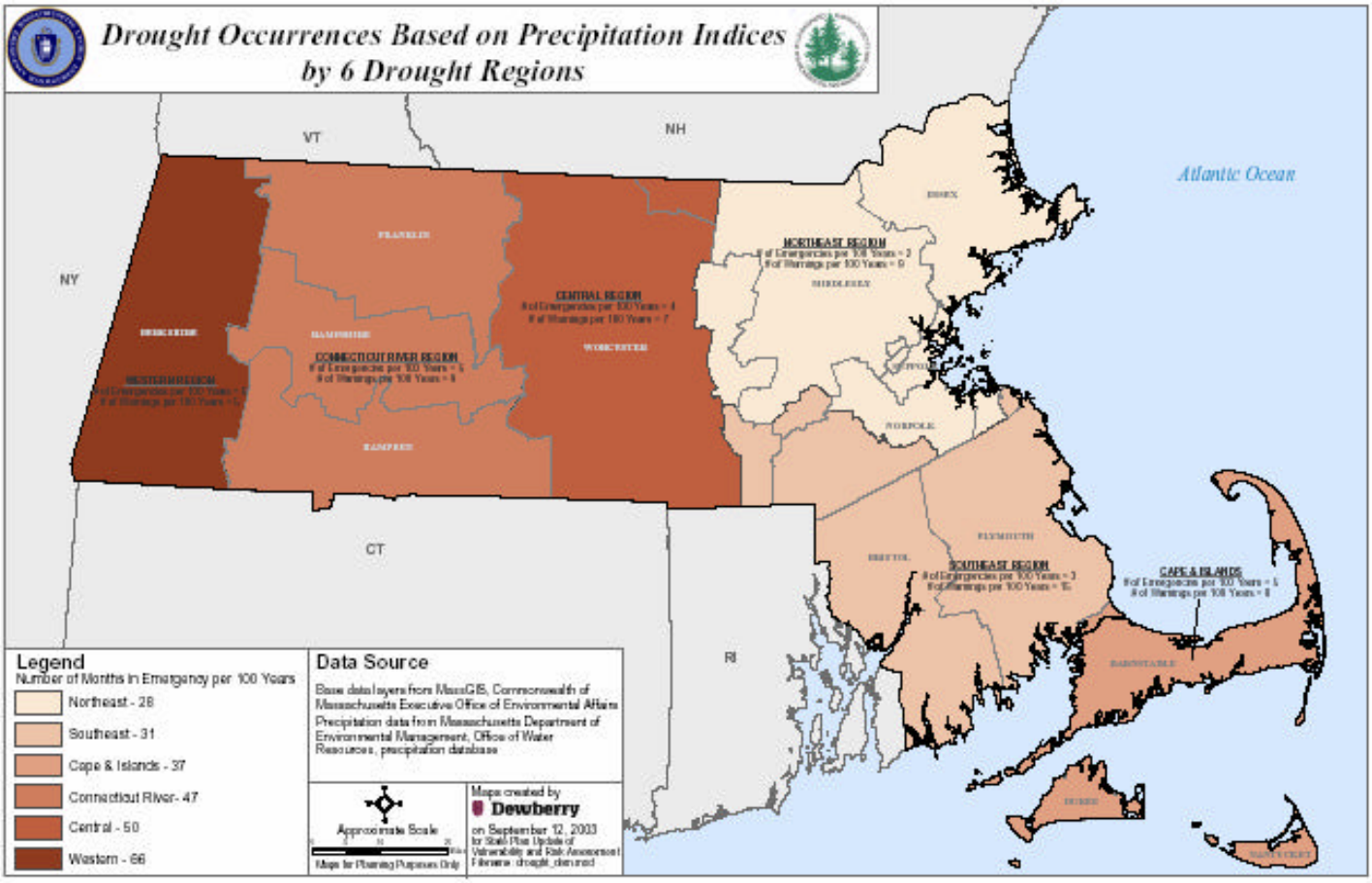
Drought Action Levels

Unlike many other emergency situations, the severity of droughts develops over time and therefore present the opportunity to develop and implement appropriate measures as the situation worsens. Therefore, the Massachusetts Drought Management Plan defines action levels that define general levels of response given the severity of the situation.

Drought Level	*Response/Actions*
Normal Conditions	(1) DCR collects basic weather and hydrological data and produces monthly "Current Conditions" report. (2) DEP encourages communities to adopt local bylaws that provide for drought related contingency plans.
Drought Advisory	(1) DCR distributes monthly summary of dry conditions (Current Conditions Report) to DMTF. (2) DEP communicates with municipalities and Massachusetts Water Works about dry conditions. (3) MEMA/EOEA contact members of DMTF and call a meeting of DMTF. (4) MEMA & EOEA develop general press announcements as necessary. (5) DEP/DPH/EOEA begin to coordinate on a regular basis to exchange information regarding status of drinking water supplies. (6) DFA/DFW/EOEA being to coordinate on a regular basis to exchange information regarding the status of agriculture, fisheries and wildlife impacts (7) Agencies expand data collection and monitoring. Forward "Current Conditions" report to drought task force coordinators.
Drought Watch	(1) Assessment and recommendations coordinated through Drought Management Task Force (DMTF). (2) Intensified monitoring and appraisal of drought situation through information gathering of state agencies. (3) DEP offers technical assistance to communities on managing systems during dry conditions, including assistance on use of emergency connections and supplies. (4) DEP ensures towns know how to request a declaration of drought emergency. (5) DFA/DFW provide more detailed assessment of environmental/agricultural impacts of worsening conditions. (6) DMTF coordinators undertake public information distribution regarding current conditions and general conservation measures. (7) DMTF coordinators develop press strategy to communicate information on drought. (8) DMTF coordinators prepare memorandum on status of situation for Secretaries of Environmental Affairs, Public Safety and Commissioner of Public Health. (9) Initiate contact and planning efforts with federal agencies.
Drought Warning	(1) Develop measures to reduce water use and protect public and vital health, economic and environmental interests. Fully implement and promote public information and technical assistance. (2) EOEA and MEMA implement press strategy to keep media and public informed about the situation (3) DMTF coordinators collect information on availability and use of emergency sources of water. (4) DPH works closely with local boards to assess public health threats and take actions as needed. (5) Initiate contact and planning with New England states and New York regarding situation and to alleviate drought impacts. (6) Prepare Governor Proclamation of a drought emergency in regards to a potential drought emergency. (7) Recommend to Governor on communications strategy. (8) Develop recommendations for special legislation and/or funding. (9) Begin process to utilize appropriate federal assistance options.
Drought Emergency	(1) Finalize Governor Proclamation of a drought emergency to utilize state emergency authorities and powers to restrict water uses and implement measures to provide emergency water supplies. (2) DMTF continues to coordinate response of state, local and federal agencies. (3) Secure emergency funding and/or legislation. (4) Secure federal assistance.

Massachusetts has a number of distinct regions that can experience significantly different weather patterns and react differently to the amount of precipitation they receive. Therefore, assessments of drought conditions by the Drought Management Task Force are undertaken on a regional basis, rather than using a single statewide assessment.

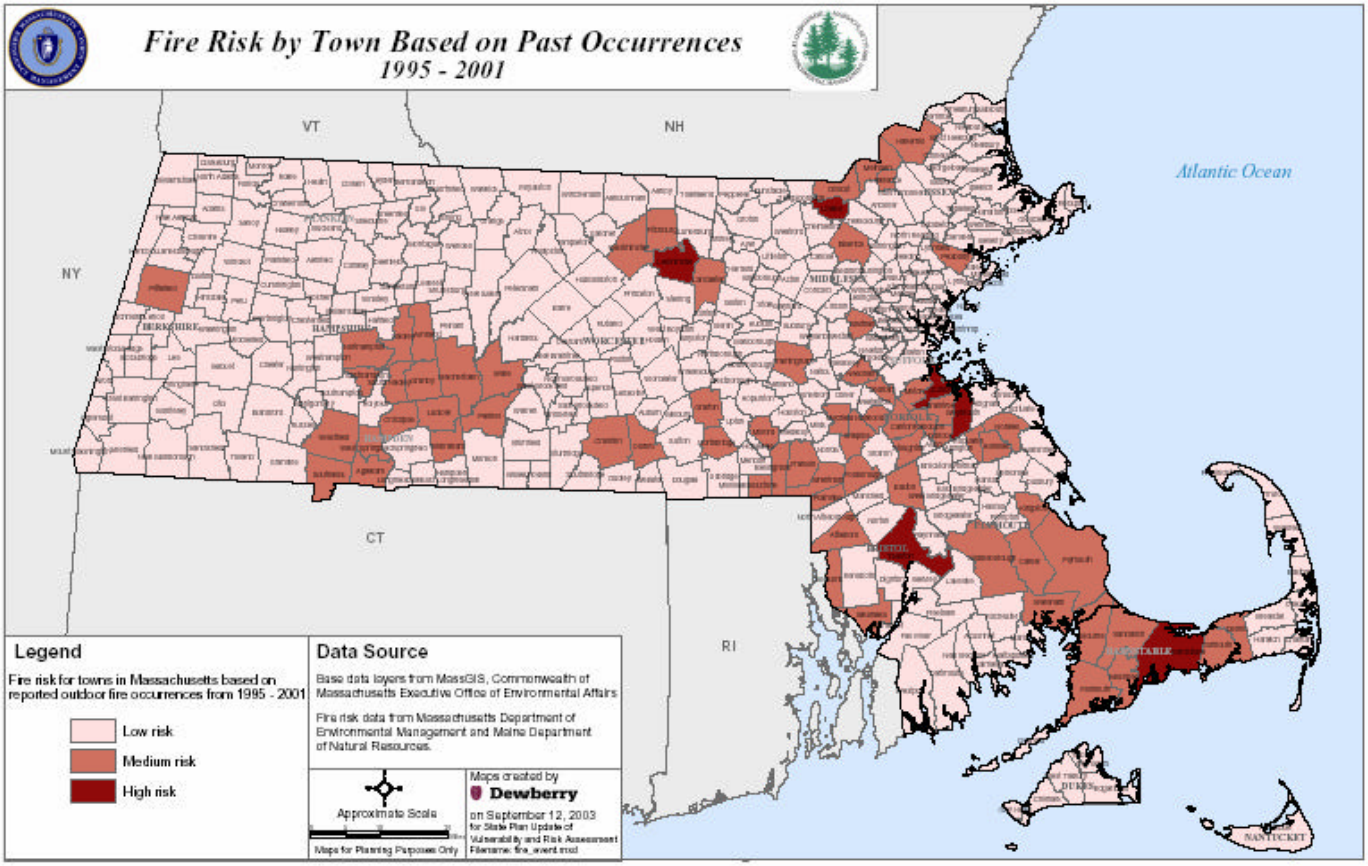
The precipitation index, used by DCR, divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands (see map below). Because drought conditions may vary due to precipitation patterns, these regions may be adjusted based on the conditions in any particular drought situation. In addition, areas served by water supplies outside their region (most notably the Massachusetts Water Resources Authority (MWRA) water communities) will have their drought conditions assessed by the capacity of their system, rather than by the regional indices. The purpose for a regional approach is to allow regions to customize drought actions and conservation measures as needed to address the particular situation in each region. These regions also vary in population, density, water demand, topography, and runoff characteristics. Because of these different characteristics, different responses may be needed.



Areas at Risk: In order to develop a statewide overview of areas vulnerable to past drought conditions, the aforementioned precipitation regions as defined in the Massachusetts Drought Management plan as well as the plan's definition of a drought emergency were used for data collection purposes. A drought emergency is one in which state-mandated water restrictions or use of emergency supplies is necessary. In reviewing historical data on past drought event, the above map of past drought conditions was developed by Dewberry. A larger version of this map may be found in Appendix F.

Based on past events and current criteria outlined in the Massachusetts Drought Management Plan, it appears that western Massachusetts may be more vulnerable than eastern Massachusetts to severe drought conditions, however, many factors, such as water supply sources, population, economic factors (i.e. agriculture based economy) and infrastructure, may affect the severity and length of a drought event. The Massachusetts Drought Management Plan, as previously mentioned, takes into account regional responses to such conditions. For details on responses to droughts, see the Massachusetts Drought Management Plan online at http://www.state.ma.us/dem/programs/rainfall/droughtplan.doc.

Wildfires There were over 3,000 wildfires that burned more than 2,600 acres in Massachusetts in calendar year 2002. In calendar year 2003, there were fewer wildfires with nearly 2,000 wildfires burning over 1,600 acres, possibly due to more normal precipitation levels. The majority of these fires are caused by human carelessness, (improperly disposed of cigarettes, vandalism, neglected permit fires, etc.), but some natural hazards, such as drought, may influence the number of wildfires throughout the state. Massachusetts has approximately 350,000 acres of forested wild lands owned by state agencies, with an additional 2,650,000 acres in private ownership.[xxxvii] These forests are potential fuels for wildfires. Particular areas at risk include the Southeastern area of Plymouth County, Cape Cod, and the Islands, where forested areas pose wildland fire and urban interface fire hazards. Sandy soils which dry out quickly increases the wildfire risk in this area. The following map, developed by the Dewberry Company for the Massachusetts Risk Assessment, is based on the best available data at the time (a larger version of this map may be found in Appendix H):



The most recent large-scale wildfire occurred in the Town of Russell in Hampden County in September, 1995. This wildfire, which initiated the federal Fire Suppression Agreement under a Presidential Declared Disaster (FEMA-2116-FSA), was finally controlled after two weeks. The fire's location on extremely steep terrain

made access particularly difficult. The fire burned several days as a result of ready fuel and prolonged regional drought conditions. The fire burned over 500 acres and threatened several dwellings and farms in the Town of Russell. The amount of smoke from the fire caused air pollution problems and health hazards to residents of communities as far away as the Town of West Springfield and the City of Springfield. During the time of the Russell fire, approximately 50 fires were taking place in other parts of the state, including two of approximately 50 acres each in the town of Rockport.

Massachusetts Bureau of Fire Control Report - 2002 – 2003

The Department of Conservation & Recreation's Bureau of Fire Control is managed through 13 Fire Districts. The table below depicts the total fire incidences and causes recorded by the Bureau of Fire Control. The numbers of the year of 2002 are higher due to the much drier conditions – the statewide drought advisory – throughout 2001 – 02.

Massachusetts Annual Wildfire Report			as submitted on FS-3100-8
TOTAL ACRES PROTECTED	3.5 Million		3. Calendar Year 2002

Wildfires and acres burned by cause:

Cause	Number of Fires	Number of Acres
Lightning	21	67.00
Campfire	138	89.25
Smoking	390	169.25
Debris	562	384.50
Arson	1416	1340.00
Equipment	87	156.75
Railroads	49	140.25
Children	178	186.25
Misc.	195	81.75
TOTAL	3036	2615.00

Wildfires and Acres burned by size class:

Classes	Acres	Total
Class A	2522	630.50
Class B	490	1188.25
Class C	22	496.25
Class D	2	300.00
Class E		
Class F		
Class G		
TOTAL	3036	2615.00

Massachusetts Annual Wildfire Report			as submitted on FS-3100-8
TOTAL ACRES PROTECTED	3.5 Million		3. Calendar Year 2003

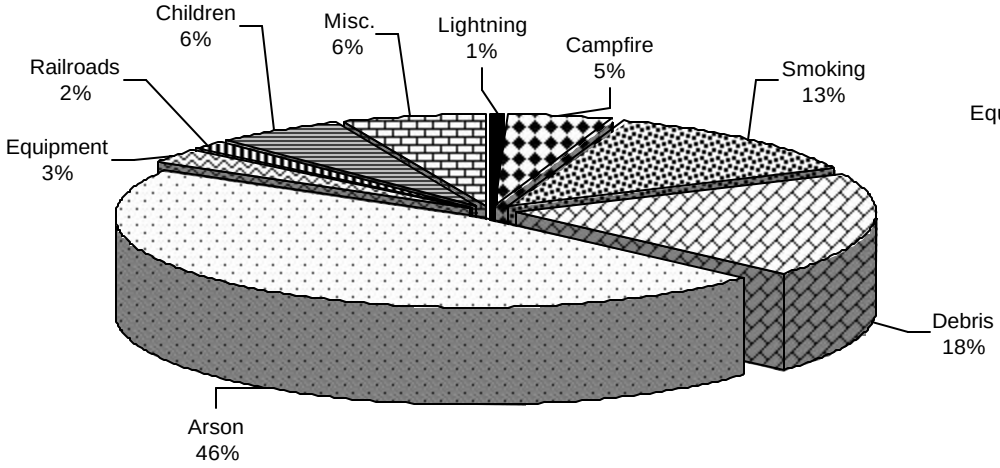
Wildfires and acres burned by cause:

Cause	Number of Fires	Number of Acres
Lightning	3	10.00
Campfire	74	45.00
Smoking	248	135.50
Debris	491	365.00
Arson	795	812.50
Equipment	5	8.50
Railroads	21	62.25
Children	155	142.25
Misc.	87	36.25
TOTAL	1879	1617.25

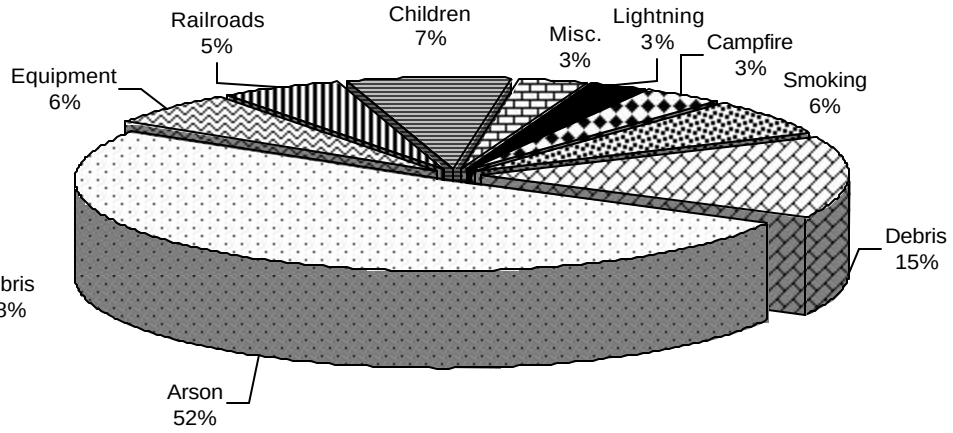
Wildfires and Acres burned by size class:

Classes	Acres	Total
Class A	1529	382.25
Class B	328	540.00
Class C	21	395.00
Class D	1	300.00
Class E		
Class F		
Class G		
TOTAL	1879	1617.25

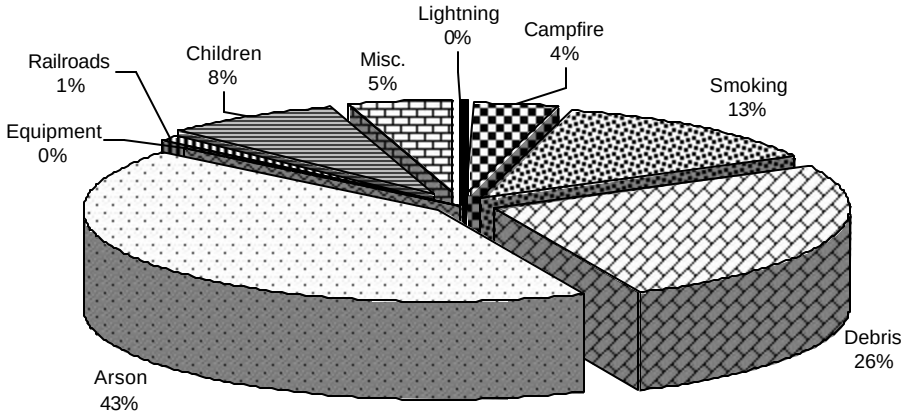
2002 Wildfires by Cause
(Percentage)



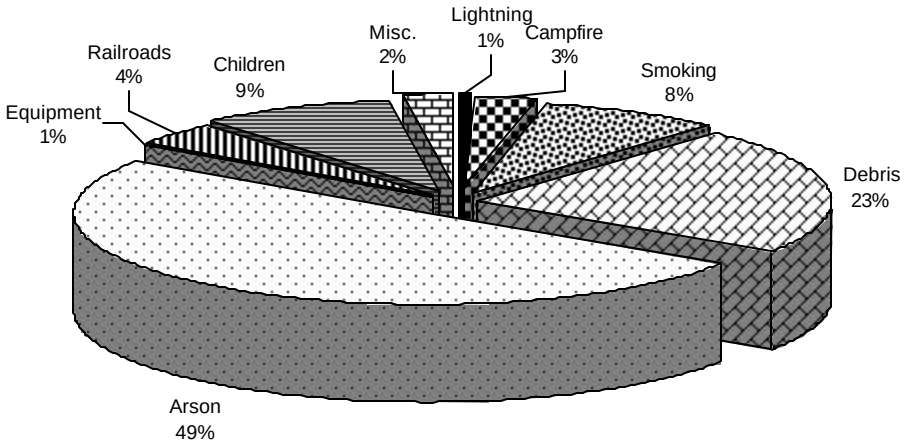
2002 Acreage by Cause
(Percentage)



2003 Wildfires by Cause
(Percentage)



2003 Acreage by Cause
(Percentage)



Source: 2003 MA Bureau of Fire Control Annual Report, see Appendix X

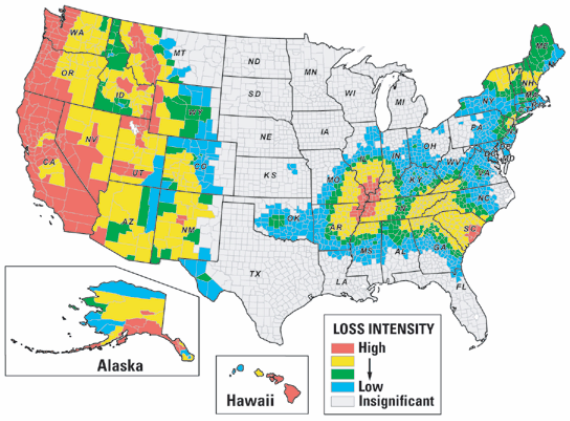
Areas at Highest Risk: Massachusetts has particular vulnerability to fire hazards where urban development and wildland areas are in close proximity. The "wildland/urban interface" is where many fires are fought. The wildland areas are subject to fires because of weather conditions and fuel supply. Taken alone, wildland fires are less of a problem than is the combined effect of having residences, businesses, and lifelines near the wildland areas. Thus, a fire might in the past have been allowed to burn itself out with a minimum of fire fighting or containment must now be fought to prevent not only fire damage to surrounding homes and commercial areas, but also to prevent smoke threats to health and safety in these areas. [xxxviii]

Despite extensive Massachusetts state regulations governing fire prevention, control and suppression, which are generally more protective than in other areas of the United States, there are still specific areas which are especially vulnerable to wildfire hazards. These include rural areas where personnel and specialized equipment to handle major fires are scarce as well as the wildland/urban interface areas around areas of open spaces, such as federal and state park langs. As previously mentioned, the southeastern part of Massachusetts, from the Fall River area to all of Cape Cod as well as Martha's Vineyard, is susceptible to wildland fires due to the availability of fuel (types of trees) and increasing development within the wildland/urban interface as the population of Cape Cod has increased by 19.1% between 1990 and 2000 while the population of Massachusetts grew only 5.5%.[xxxix] This growth rate is just for the year round population and not the additional visitors during the summer months.

Although there was no loss of life associated with wildfires in Massachusetts in the Russell fire or during 1994, one-third of all firefighters who died in the line of duty in the U.S. were killed fighting wildland fires. There is a high cost , both economic and in terms of lives lost, of fighting fires in the wildland/urban interface since the location of homes near high hazard fire areas means effort must be expended to save infrastructure, rather than to allow the wildfire to burn.[xl]

Vulnerability to Geologic-Related Hazards

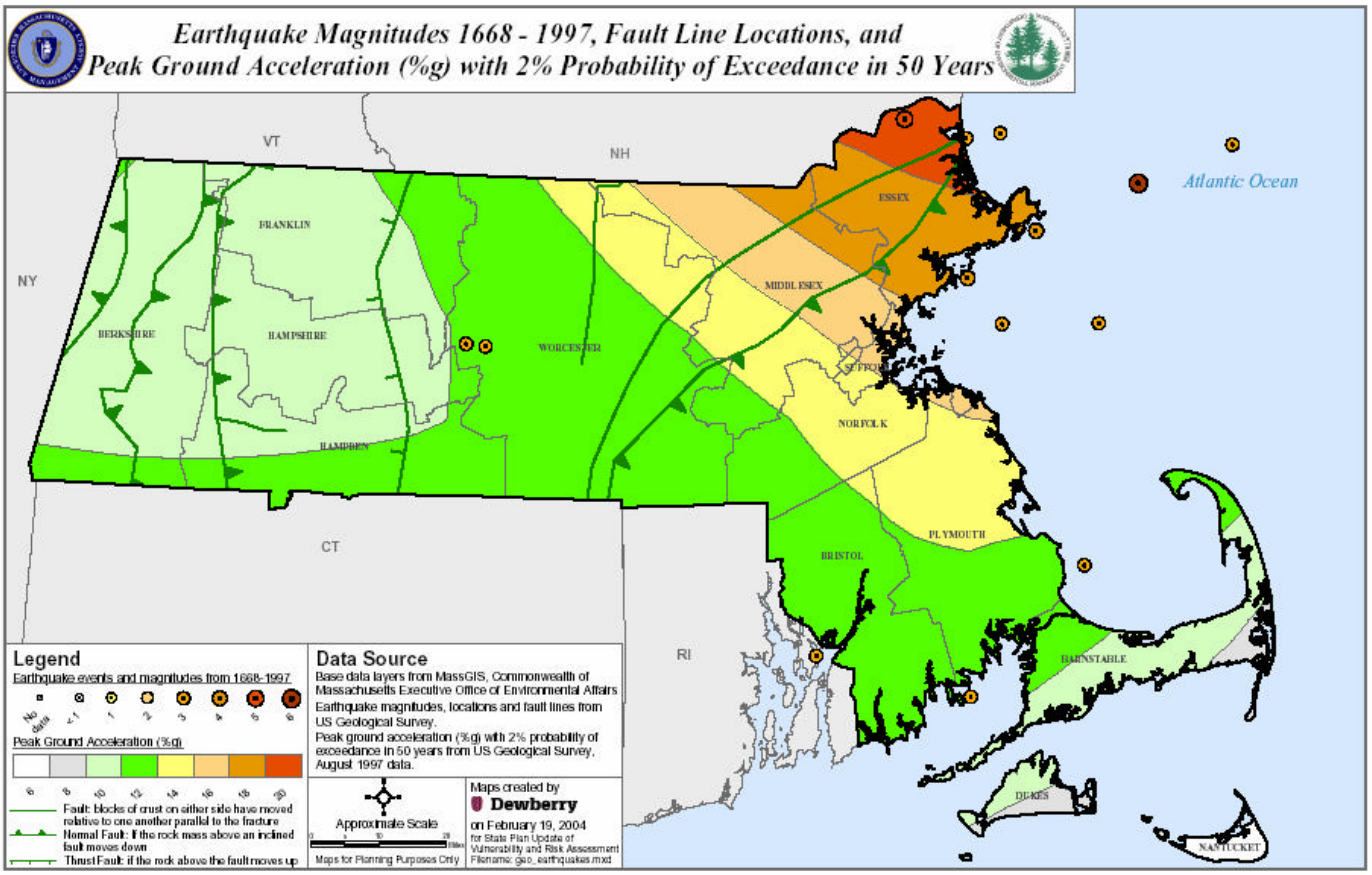
Earthquakes –The last major earthquake to affect Massachusetts was more than 200 years ago in 1755 with an estimated magnitude of 5.75. The epicenter was located off the Cape Ann coast, north of Boston. The area of greatest damage stretched along the northern Massachusetts coast from Cape Ann to Boston, where chimneys were shattered and objects were flung from shelves. New England is located in approximately the middle of the North American Plate. One edge of the North Atlantic plate is along the coast of California and the eastern edge is just past the middle of the Atlantic Ocean. The exact earthquake mechanism is still unknown; however, New England's earthquakes appear to be the result of the cracking of the surface due to the compression and buckling of the North Atlantic plate. The forces on this plate that initiate the buckling include the downward weight of the



Future Earthquake Losses
Source: USGS Earthquake Hazards Program 2004

mountains and the upward stress relief caused by the retreat of the glaciers. Given this information on the geography of New England, and based solely on known past earthquake activity, the three most likely source areas for earthquakes with potential damage are: eastern Massachusetts and the Cape Ann area; central New Hampshire in the Ossipee area; and at the La Malbaie region, Province of Quebec.

Even with this information about plates, seismologists have established that the New England epicenters do not follow the major faults of the region, nor are they confined to particular geologic structures or terrain. In general, New England's earthquakes have no known relationship to existing faults. This is in complete opposition to that in California. In New England, unlike the west coast, earthquakes occur all over; no one can say for certain that they will occur in a specific location.



The preceding map of the Commonwealth shows the following:

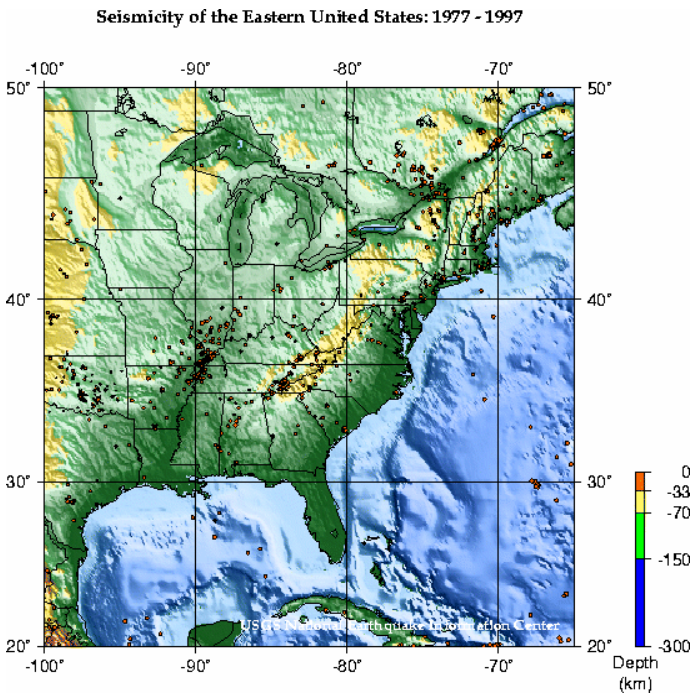
- Point locations of earthquake event epicenter locations between 1668 and 1997 with magnitude of events depicted by graduated symbols;
- Fault line locations; and
- Peak Ground Acceleration (PGA) zones, expressed as percentages of gravity for areas with a two percent probability of the depicted PGA being exceeded in a 50 year period.
- Earthquake magnitudes, locations, fault lines and PGA data were available from the USGS Earthquake Hazards Program website: http://eqhazmaps.usgs.gov/.

Information sources located from the website included: USGS, *2002 National Seismic Hazard Map: Central and Eastern United States Maps*; and U.S. Geological Survey Geologic Investigations Series I-2737, *Earthquakes in and Near the Northeastern United States, 1638-1998* by Russell L. Wheeler, Nathan K. Trevor, Arthur C. Tarr, and Anthony J. Crone, 2001. Additional data were examined from the National

Seismic Hazard Mapping Project web site: http://geohazards.cr.usgs.gov/eq/index.html and the Weston Observatory. The USGS source provided the best data in a format suitable for mapping within the scope of this project. The National Seismic Hazards Mapping Project, as its name implies, focuses on National maps of earthquake shaking hazards to provide information essential to creating and updating the seismic design provisions of building codes used in the United States. Scientists frequently revise these maps to reflect new knowledge.[xli]

In an attempt to quantify the risk of damages due to an earthquake throughout the United States, USGS, through the Earthquake Hazard Program has developed maps displaying likely levels of ground motion due to future earthquakes. When developing these maps, USGS considered the potential magnitude and locations of future earthquakes based on historical data and geological information on the recurrence intervals of fault ruptures. Using this data, the extent of potential ground shaking with a 10 percent, 5 percent, and 2 percent chance of being exceeded in a 50 year period has been calculated, and contour lines have been interpolated to be displayed on hazard maps.

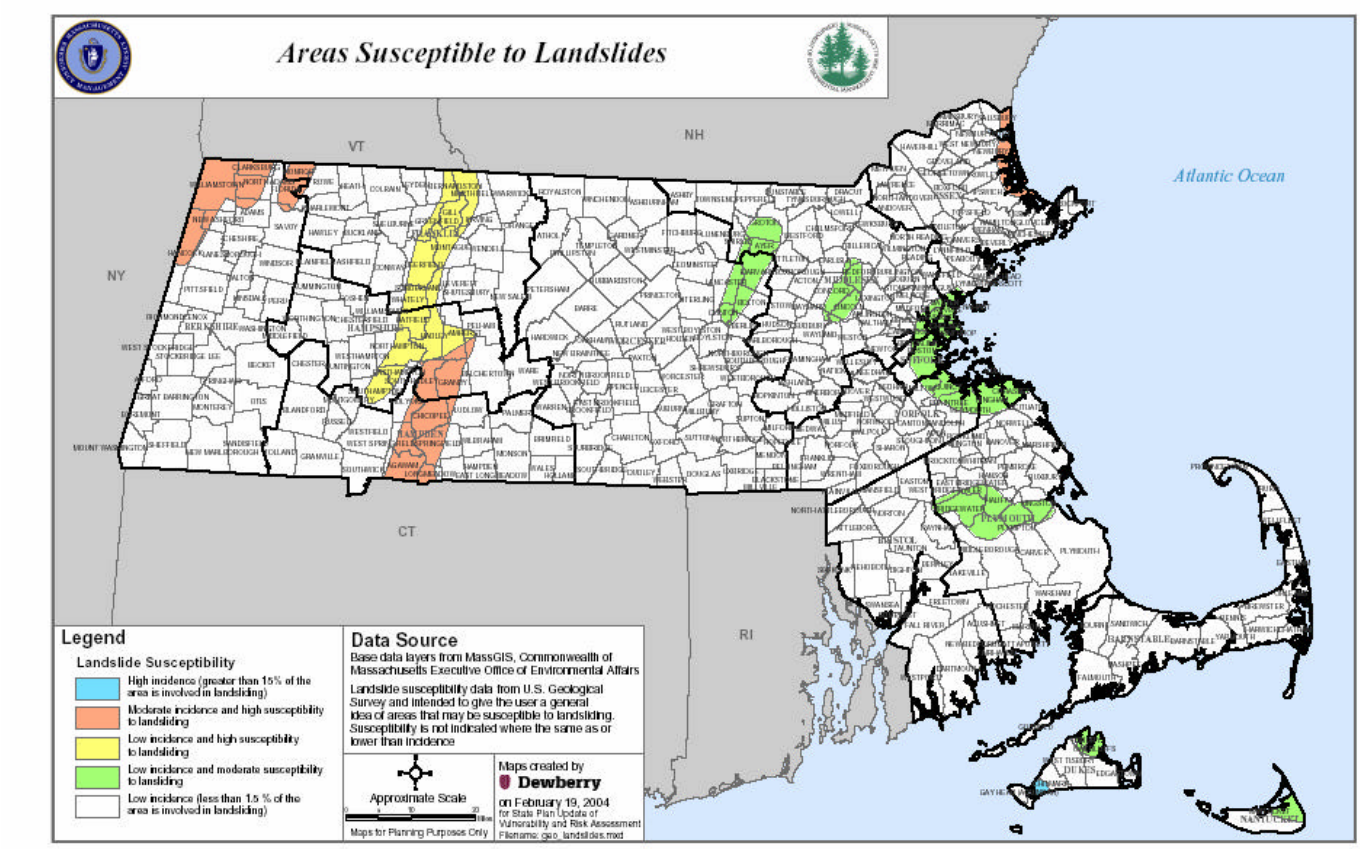
The most commonly used method to quantify potential ground motion is in terms of peak ground acceleration (PGA). PGA measures the strength of a potential earthquake in terms of the peak acceleration of ground movement. The potential damages due to an earthquake increase as the acceleration of ground movement increases. Peak ground acceleration is expressed as a percentage of a known acceleration, the acceleration of gravity (9.8m/s^2), and is commonly referred to as "%g" as described in the previous map on Peak Ground Acceleration.



Therefore, the geographic areas with the highest PGA have the highest potential for damages during an earthquake. For example, a PGA of .5g is equal to 50% of 9.8 m/s^2 or 4.9 m/s2. PGA levels are commonly calculated for a specific probability of being exceeded in a period of time. The PGA levels on this map are those which have only a 2% chance of being exceeded in a 50 year period.

Areas at Highest Risk: Based on the data provided by USGS and the PGA depicted on the preceding map, it appears that northeast Massachusetts, especially along the Massachusetts coastline, from the Plymouth county area, the Boston Metropolitan area, up to the New Hampshire border, is slightly more vulnerable to potential earthquake activity than other areas.

Landslides – The map below depicts areas of high and low incidents, and areas of moderate and low incidents combined with high and moderate susceptibility (see legend). The data collected for this map are from the USGS National Landslide Information Center: http://landslides.usgs.gov/html_files/nlicsun.html. Data provided from the center are digital versions of U.S. Geological Survey Professional Paper 1183, *Landslide Overview Map of the Conterminous United States*. By Dorothy H. Radbruch-Hall, Roger B. Colton, William E. Davies, Ivo Lucchitta, Betty A. Skipp, *and* David J. Varnes, 1982.



The map and digital data delineate areas where large numbers of landslides have occurred and areas which are susceptible to landsliding in the conterminous United States. Because the data are highly generalized, owing to the small scale and the scarcity of precise landslide information for much of the country, they are unsuitable for local planning or actual site selection at this scale. Rather they are intended to provide a general overview and a tool for map users to know that further local investigation of landslide potential may be warranted when planning or developing in the general area. Furthermore, this layer is not intended to include all areas in the Commonwealth that could be prone to land sliding.

The USGS bases susceptibility to landslides on combinations of the above defining factors, including general soil characteristics. Incidents are presumably based on reported or known incidents of landsliding. However, data could not be found from the USGS sources to demonstrate actual incidents, nor could the period of record. The USGS definition of susceptibility is: "The probable degree of response of formations to natural or artificial cutting, loading of slopes, or to anomalously high precipitation. "

Areas at Highest Risk: Based on the USGS maps, areas along the Connecticut River in western Massachusetts in the Pioneer Valley and Franklin County areas.

Vulnerability to Other Hazards

Since this plan focuses on natural hazards, no attempt was made to analyze the vulnerability to technological and man-made hazards by jurisdiction. Any existing analyses would be contained in the plans identified in the chart of Massachusetts Plans Addressing Other Potential Hazards on pages 50 to 52.

4.4 Assessing Vulnerability of State Facilities

The majority of the information for this section has been developed as part of the "Pre-Disaster Mitigation Program Grant State Plan Update of Vulnerability and Risk Assessment" developed for Massachusetts by Dewberry in 2002 – 2003. Due to large amount of data, the state and Dewberry agreed that this information would be presented in a narrative format, and where valuable, tabular format, along with the comprehensive spreadsheet of all of the facilities from multiple DCAM datasets rectified and hazard rankings included for flood, earthquake/geologic, Sea and Lake Overland Surge from Hurricanes (SLOSH), wind and tornado hazard areas. Dewberry compiled a central database from the three datasets provided by the Massachusetts Department of Capital Asset Management (DCAM). The database was then linked to the GIS files (the natural hazard maps listed throughout Section 4 of this plan) to identify which of the 5,000 plus state-owned facilities are located with in the five mapped hazard areas selected for analysis.

A comprehensive electronic inventory of state owned property for use in developing this part of the state plan was obtained from DCAM. This state agency retained the consulting firm of Parsons-Brinkerhoff in 2002 to develop its statewide inventory and obtain Geographic Positioning Satellite (GPS) coordinates for the buildings. This inventory included names of the state agencies, locations, descriptions, agency contacts and estimated dollar value of each facility. Number of people employed by facility was not available in a digital format and this information is included in this plan.

In addition, this information does not include a ranking of non-building state property (e.g. parks, open space, etc.) for a variety of reasons. Foremost, from the data available, it would not be possible to know which portions of large properties would fall into often geographically small hazard areas. For example, if a 1000 acre parcel of land contained a small area of floodplain, it would be misleading to characterize the entire parcel as a high or medium risk property. Secondly, information pertaining to building and appurtenances were not specifically located on the properties (i.e. by coordinates) and therefore couldn't be located specifically. Many of these appurtenant structures (e.g. out houses, guard shacks, bleachers, etc.) were either included in the facility datasets already or not practically worth including at a statewide scale. There was fear that by including these properties at this scale it might "double count" some structures and could artificially inflate the amount of at risk property that the plan would examine as realistic and cost effective mitigation targets.[xlii]

It should also be noted that there have been changes to the names and administrative structure of several Commonwealth agencies since the commencement of this project.

Vulnerability of State Facilities to Flood-Related Hazards

In order to assess the vulnerability of the state-owned facilities identified in the DCAM database, the Dewberry report determined that the FEMA Q3 flood data would be the most appropriate for use in this assessment, as it is based actual flood studies of the particular flooding sources through the development of FEMA's Flood Insurance Rate Maps. This data includes the locations and boundaries of the FEMA flood zones, including the 100-year flood zones, including both A zones and V zones, as well as the 500-year flood zones. Using GIS software, this data was overlaid with the state-owned facility data from DCAM and the appropriate flood zone determination was assigned to each facility. It is important to note that this determination was made for planning purposes only and should not be considered accurate to the parcel and structure levels.

Once the appropriate flood zone was determined for each structure, a corresponding level of risk was assigned on a scale of high, medium, or low. Although numerous combinations of riverine and coastal flood zones are included on the maps, in general all structures fell within a 100-year V-zone, a 100-year A-zone, outside of a Special Flood Hazard Area (SFHA), or in an area that had not yet been studied. The following table summarizes the risk level assigned to the appropriate flood zone.

Risk Level	Flood Zone
High	V-Zone
Medium	A-zone
Low	Non –SFHA, unstudied area

Structures only located within the 100-year floodplain were not assigned a value of high risk because, by definition, the potential frequency of impact is relatively low. However, due to the high levels of damage that are typically sustained by structures in the 100-year V-zone due to the forces of associated waves, structures located within the V-zone have were assigned a level of high risk. Structures located in the 100-year flood zone, or A-zone, were assigned a medium risk, and all other structures were assigned a low risk. Using the risk levels assigned above, 34 structures are located in a high risk area, and 245 are located in areas designated to be medium risk. Using the replacement value included in the DCAM data, the total value of state owned facilities located in the high risk areas is over $41 million, while the value of the state owned facilities located in a medium risk area is over $369 million.

As detailed in the following table all of the structures determined to be in a high risk area are contained within the counties of Bristol, Barnstable, Plymouth, and Suffolk Counties. In general, the numbers of structures included in the medium risk areas are evenly distributed over the remaining counties. The counties with the higher number of state owned facilities in the medium risk areas correspond with those with a higher overall number of state facilities.

Total State-Owned Structures in Flood Risk Zone by County

County	Total State - Owned Structures	High Risk	Medium Risk	Low Risk
BARNSTABLE	265	10	16	239
BERKSHIRE	314	0	18	296
BRISTOL	404	17	24	363
DUKES	9	0	0	9
ESSEX	449	0	17	432
FRANKLIN	192	0	1	191
HAMPDEN	389	0	13	376
HAMPSHIRE	626	0	14	612
MIDDLESEX	1027	0	41	986
NANTUCKET	8	0	0	8
NORFOLK	631	0	31	600
PLYMOUTH	491	6	15	470
SUFFOLK	258	1	35	222
WORCESTER	911	0	21	890
Grand Total	**5974**	**34**	**246**	**5694**

An analysis was also undertaken to determine which state agencies had the most facilities in the high risk areas. All 34 of the high risk structures owned by the Commonwealth are under the control of 3 agencies: The Department of Conservation and Recreation (DCR), which was formed following the merger of the Department of Environmental Management (DEM) and the Metropolitan District Commission (MDC), the Massachusetts Maritime Academy (MMA), and the Massachusetts Highway Department (MHD). In addition, 65% of all structures located within the medium risk areas also fall within the control of DCR and MHD, and MDC. The following table includes the number of facilities located in the flood risk zones by agency for those with the highest number of structures and includes the total replacement value for the agencies.

Total State Agency-Owned Structures at Risk of Flooding

State Agency	Total Structures	High Risk	Medium Risk	Total in Hazard Areas	Replacement Value of Structures in Hazard Areas
Dept. of Conservation & Recreation (DCR) (formerly DEM & MDC)	1532	21	126	137	$127 million
Massachusetts Highway Department	751	3	33	36	$9 million
Massachusetts Maritime Academy	21	10	10	20	$49 million
All other state agencies	3670	0	77	77	$227 million
Grand Total	**5974**	**34**	**246**	**280**	**$412 million**

As stated previously the analysis described above utilized FEMA Q3 flood data to determine the location of the floodplain. Because this data is compiled in a regional manner, the accuracy of the floodplain boundaries applied at the structure level is questionable. To account for this lack of precision a 100 foot buffer was utilized for all flood zones in order to identify any additional structures that may be located in the floodplain, and thus one of the risk zones described above.

Because many structures that fall into one of these buffer zones may have already been included in the lists above, only those structures that were determined to not fall within one of those risk zones, or which fall in the buffer of a higher risk zone have been included in this additional list. For example, a structure previously determined to be in a SFHA A-zone or "Medium" risk zone that also falls within the buffer of the X500 zone would not be included in this list because this structure has already been included in the previous analysis. However if a structure that is located in a "Medium" risk zone is determined to fall within the buffer of a V-zone or "High" risk zone, this structure has been included in the list of structures falling in the buffer zone, because this potential additional risk has not been captured in the previous analysis.

Structures Falling within 100 Foot Buffer Zones by County

A total of 138 additional structures are located within these flood "buffer" zones, with 19 falling within the buffer of the high risk zones and 119 falling within the medium risk zones. Of the 19 falling within the buffer of the high risk zone, none were also in the medium risk zone. These structures have an estimated replacement value of approximately $411 million dollars. The following table includes a list of these structures catalogued by county.

County	High Risk	Medium Risk
BARNSTABLE	0	5
BERKSHIRE	0	6
BRISTOL	1	13
ESSEX	2	9
FRANKLIN	6	0
HAMPDEN	0	8
HAMPSHIRE	0	11
MIDDLESEX	3	20
NORFOLK	0	13
PLYMOUTH	1	5
SUFFOLK	1	11
WORCESTER	5	18
Grand Total	**19**	**119**

Sea, Lake and Overland Surge from Hurricanes (SLOSH) Inundation Areas

The hurricane SLOSH data obtained by Dewberry was obtained in two separate formats. The SLOSH zone data for all areas along the Massachusetts coastline from the Cape Cod Canal north to the New Hampshire Border was obtained in a ArcView shape file format with the surge categories being assigned corresponding to a category 1, category 2, category 3, and category 4 hurricane. For the structures within this region of the State, the digital SLOSH data was overlaid with the structure data and the appropriate SLOSH zone was determined.

For the areas along the coast from the Cape Cod Canal south to the Rhode Island border, SLOSH data was not available in a geo-referenced digital format, but was available as individual CADD files for each community. Because these files were not geo-referenced, the locations of specific structures could not be digitally compared with the SLOSH zones for these areas. Therefore, by plotting both the locations of the

state owned facilities in these areas, as well as the community maps displaying SLOSH zones for these communities, an appropriate zone was assigned to each facility within these communities. In these areas the surge classifications were formatted differently than other areas of the state, visually.

In these communities with older mapping, the SLOSH Zones were classified as either as inundation zone A, inundation zone B, and inundation zone C, which represent a combination of varying categories of storms moving at different ranges of forward speed. In order to complete a consistent ranking for all facilities throughout the state, the two different methods of classifying storm surge zones had to be combined. Using the definitions of the SLOSH zones provided with the USACE data, determinations were made to convert the SLOSH for the areas south of the Cape Cod Canal, to the format utilized throughout the state. The following table displays how these SLOSH zones were combined.

Inundation Zone	Storm Category (Saffir/Simpson Scale)
A	1 or 2
B	3
C	4

Once all the SLOSH data had been combined to be expressed only as storm category, risk levels were assigned for each category. When determining the level of risk for each category of inundation, most consideration was given to the frequency of impact. Although the magnitude of impact will differ for each structure depending on the surge zone, the relatively low frequency of impact of these events decreases the overall risk to those structures. In addition, the lower frequency of impact of storms, with higher magnitude, causes the risk levels for structures located in the surge zones of these events to actually have a lower risk level. Due to the overall low frequency of a storm of any magnitude impacting the Massachusetts coastline, it was determined that no structures could be determined to be at a high risk to impact due to storm surge inundation due to a hurricane. Therefore, all facilities or structures located in the in surge zone for a Category 1 or 2 storm were assigned a risk level of medium, while those located in the surge zone for a Category 3 or 4 storm were assigned a risk of low. It should be noted that structures located in Category 1 and 2 surge zones are by default also subject to the risk of Category 3 or 4 surges.

Using the risk levels described above, a total of 309 structures or facilities, or about 5% of state-owned facilities, are located within the SLOSH inundation zones, with 256 located within the medium risk zone, and 53 structures are located within the low risk zone. All other state owned structures or facilities are not located within a defined SLOSH zone. The total estimated replacement value of the structures located in the low risk area is $226 million dollars, while the value of that located in the medium risk is $1.5 billion. The following table summarizes the number of structures in these zones and includes the total estimated replacement value for each zone.

The following table includes a breakdown of these structures by county and includes building replacement value.

State-Owned Facilities by County at Risk for Overland Tidal Surge from Hurricanes

COUNTY	Total Structures	Medium Risk	Low Risk	Replacement Value of Structures in Hazard Areas*
BARNSTABLE	265	43	9	$59 million
BRISTOL	404	37	0	$11 million
DUKES	9	4	0	$5.7 million
ESSEX	449	27	21	$130 million
MIDDLESEX	1027	20	4	$38 million
NANTUCKET	8	4	0	$1.1 million
NORFOLK	631	7	2	$10 million
PLYMOUTH	491	30	6	$16 million
SUFFOLK	258	84	11	$1.5 billion*
All other counties	2432	0	0	none
Grand Total	**5974**	**256**	**53**	**$1.8 billion***

Special Note: The high estimate for "Replacement Value of Structures in Hazard Areas" within Suffolk County is largely the result of a few large Boston office buildings having been identified as within the hazard area through a GIS overlay process. Due to the topography and dense development patterns in Boston, small refinements to this analysis could result in a large variability in the estimate of structure value within hazard areas. Local hazard analyses will examine these types of areas in more detail to better refine the estimates.

The 309 facilities and structures are managed or operated by 18 different agencies, although 240 of these structures, or 78%, are managed by only six agencies. The following table includes a list of the seven agencies and the total number of facilities in each risk category, as well as the total replacement value by agency.

State Agencies Owning Facilities within SLOSH Zones

Agency	Total Structures	Medium Risk	Low Risk	Replacement Value of Structures in Hazard Areas*
Dept. of Conservation & Recreation (DCR) (formerly DEM & MDC)	1532	118	24	$139 million
Fisheries Wildlife & Environmental Law Enforcement	155	16	0	$3.9 million
Massachusetts Highway Department	751	26	3	$32 million
Massachusetts Maritime Academy	21	20	0	$50 million
Salem State College	35	7	10	$80 million
University of Massachusetts	497	17	4	$25 million
All other agencies	2983	52	12	$1.4 billion*
Grand Total	**5974**	**256**	**53**	**$1.8 billion***

**See special note above.*

Vulnerability of State Facilities to Wind Hazards

The state of Massachusetts is divided into three wind zones, the limits of which are defined by the Massachusetts State Building Code along county boundaries. The basis of these wind zones, as defined by the State Building Code, is a set of national wind data prepared by the American Society of Civil Engineers. The data can be found in a document titled, ASCE-7 "Minimum Design Loads for Buildings and Other Structures." The document establishes seven wind zones throughout the nation, with the three zones located in Massachusetts being at the lower end of that range. Because the goal of this document is to assign risk levels relative to the entire national range of risk, it was determined that a majority of the structures in the Massachusetts would be assigned a low risk to wind damage. The wind zone with the highest wind speed, located in the eastern portion of the Commonwealth and including all counties east of Worcester County, has been designated as a medium risk.

Because of this designation all state owned structures and facilities located in Essex, Middlesex, Suffolk, Norfolk, Bristol, Plymouth, Barnstable, Dukes, and Nantucket Counties are located have been given a medium risk designation. This includes 3543 total structures or 59% of all state owned facilities. The facilities are managed or operated by 42 separate state agencies, and have a replacement value over $10.8 billion.

The tornado risk information presented earlier in this plan calculated and displayed the density of historical tornados. The state was divided into 5 areas of varying density of historical tornados, with the highest historical density of tornados occurring in the central and northern portions of the state. The values for these varying levels of historical occurrences range from .0029 tornados per 20 square mile cell within the each density zone to .0206 tornados over a 50 year period. [Refer to the Research Methodology and Data Collected section of Appendix X for additional information on the methodology of this mapping and analysis.] As with other hazards, in order to determine an appropriate risk level for the structures throughout the Commonwealth, a relative understanding of how the tornado risk in the Commonwealth compares to other areas of the country needed to be established.

In order to accomplish this task, historic tornado data for a number of other states throughout the country was obtained. Using the total number of tornados in each of these states, as well as the respective total land area, the average number of tornadoes in a 20 square mile area was determined. The states included in this analysis were Pennsylvania, Texas, Florida, Oregon, North Carolina, Nebraska, Missouri, Ohio, Illinois, and Massachusetts. In evaluating and examining this data Massachusetts ranked just below the mean level of tornado density for all states evaluated. Therefore, the two areas of highest level of tornado density in Massachusetts have been designated as having a medium tornado risk, while the remaining areas where designated as having a low tornado risk.

Using the above referenced criteria, 4136 of the state owned facilities are located in the area designated as a medium risk to tornado events. The structures have a total replacement value of over $12.7 billion. Considering the large numbers of structures located within these higher than average tornado risk areas, no further trends regarding asset type, responsible agency, or county are included in this report.

Vulnerability of State Facilities to Fire-Related Hazards

The vulnerability of state facilities to fire-related hazards, especially wildfires, is currently difficult to determine based on the current, best available data. As previously mentioned in the section which describes the risk of wildfires throughout the state, there is a lack of consistent data on previous wildfire and man-made fire occurrences. The previously mentioned map of known wildfire and man-made fires is a preliminary attempt in tracking these fire occurrences. Because of this lack of credible data related to wildfires, Dewberry didn't conduct a vulnerability assessment of the wildfire risk. On page 14 of the Dewberry report, it states:

> *"Dewberry staff met with National Fire Protection Association (NFPA) staff to inquire about statistical wildfire data stored electronically by county or community in Massachusetts. The data does not exist. Dewberry staff contacted Alan Dunham, Fire Weather Program Leader, at the National Weather Service office in Taunton, as recommended by NFPA. Mr. Dunham reiterated NFPA's conclusion and acknowledged that NWS had previously looked at ways of mapping historical wildfire occurrences and could not. A combination of paper files and more recently some electronic files are kept at each of the individual Fire District Offices through out the state. Mr. Dunham suggested that the only way to obtain the data would be to visit each of the offices and convert the paper files to a spreadsheet format, which they have considered doing, but have not done due to significant cost."*

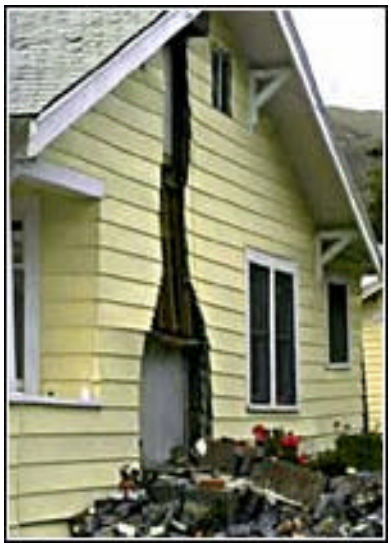
One way of determining vulnerability to wildfire is to track the potential for drought as well as the topography of particular areas, such as state-owned open space. Further statewide analysis is needed which identifies of the location of state-owned facilities in relation to wildfire-prone, topography and vegetation, such as forests of pines. The Commonwealth of Massachusetts intends to pursue this analysis in future updates to this report.

The state also expects to obtain more localized wildfire risk information from the multi-jurisdictional plans being developed by the regional planning agencies. For example, the Dewberry report notes:

> *"Dewberry staff spoke with Maisey McDarby, GIS Specialist, with the Southeastern Regional Planning & Economic Development District (SRPEDD). SRPEDD, through a grant for a local hazard mitigation plan had developed fire risk mapping for their planning area based upon topography and vegetation type. The purpose of the contact was to learn about their methodology and determine if the same could be done on a statewide basis. It was concluded that extending this methodology statewide would not be feasible within the context of this project due to the need for extensive field verification of mapping results."*

Vulnerability of State Facilities to Geologic-Related Hazards

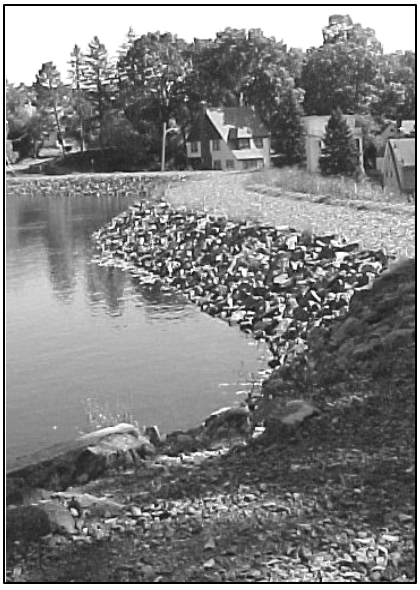
Earthquakes - The data in the Dewberry report for earthquakes included levels of ground shaking with a 2% chance of being exceeded in a 50 year period. A definition and explanation of this data is included in the Earthquake section of Appendix X. The data shows that that levels of ground shaking throughout the state range from .06g on Nantucket, to .2g in the northeastern portions of the state. According to USGS data, damages due to the effects of an earthquake will begin at a level of ground shaking of approximately .1g. The MMI intensity scale associates damages with levels of earthquakes. According to this scale, the damage that can be expected from this range of ground shaking will vary from plaster cracking and disruption of building contents, to moderate damage to poorly constructed buildings. It should be noted, however, that the expected probability of such a level of ground shaking is extremely low, and according to the USGS data can be expected to occur once every 2476 years.



Because of this low frequency of occurrence and the relatively low levels of ground shaking that would be experienced, the entire state of Massachusetts can be expected to have a low to moderate risk to earthquake damage as compared to other areas of the country. The relatively small difference in the level of impact from one area of the state to another does not justify differentiating risk levels from one portion of the state to another.

MA Mitigation Success Story:

Security for Medford Residents



Wright's Pond in Medford was both a recreational destination for residents and a source of disruption for its neighbors. The earthen dam nearly breached in 1996. Devastation was averted through the last ditch efforts of city employees building up the dam as flood levels rose. While a dam breach would have been disastrous both in terms of life and property, the repetitive flooding of nearby low-lying homes was a constant problem. Each time the inadequate overflow channel exceeded its capacity, the lowest area flooded up to three feet in depth.

In 1998, Medford was awarded a mitigation grant of $535,847.09 to eliminate the repetitive flooding, as well as, the threat of dam breach.

The Wright's Pond project was two pronged. First, construction and improvements took place to the spillway, including creating a secondary outlet, rip rapping the spillway, and upgrading road culverts along with improving adjacent drainage. Secondly, this was followed by reinforcement of the dam perimeter, added upstream riprap, and additional repairs downstream. Fencing and vegetation was then added on embankments.

In the recent flooding disaster declared in April 2004, this structure (see above photos) operated successfully. Repetitive flood damages were eliminated. Furthermore, residents benefited from increased security against dam failure.

4.5 Estimating Losses

Estimating Losses by Jurisdiction As mentioned earlier in this plan, especially in the section on Identifying Hazards (Section 4.1), Profiling Hazard Events (Section 4.2) and Assessing Vulnerability (Section 4.,3), statewide data on estimating losses may be obtained based on the statewide vulnerability assessments as well as by reviewing previous natural disasters. More than $270 million in federal and disaster assistance has been obligated to Massachusetts over the past 14 years. The following chart can gives an overview of the major disaster declarations and the costs in Massachusetts since 1991:

DISASTER NAME (DATE OF EVENT)	DISASTER # (TYPE OF ASSISTANCE)	DECLARED AREAS	FEDERAL SHARE DISBURSED	STATE SHARE DISBURSED	TOTAL DISBURSED TO DATE
Hurricane Bob (August 1991)	FEMA-914 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk	$ 28,166,029.00	$3,924,237.00	$ 32,090,266.00
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)	$ 651,881.00	0	$ 651,881.00
No-Name Storm (October 1991)	FEMA-920 (Public)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk	$ 7,737,086.00	$ 983,661.00	$ 8,720,747.00
	FEMA-920 (Individual)	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk	$ 36,225,970.00	$ 581,924.00	$ 36,807,894.00
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)	$ 626,406.00	0	$ 626,406.00
December Blizzard (December 1992)	FEMA-975 (Public)	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk	$11,929,598.00	$ 1,620,619.00	$13,550,217.00
	Hazard Mitigation Grant Program	Counties of Barnstable, Dukes, Essex, Plymouth, Suffolk (7 projects)	$400,943.00	none	$ 400,943.00
March Blizzard (March 1993)	FEMA-3103 (Public)	All 14 Counties	$,284,873.00	$183,649.00	$ 1,468,522.00
April Flood (April 1993)	STATE (Public)	Town of Hadley	0	0	$ 27,040.98
Microburst Storm (July 1994)	STATE (Public)	Town of Greenfield	0	$ 59,701.13	$ 59,701.13
Berkshire Tornado	STATE	Towns of Egremont, Great Barrington,	0	$871,632.89	$871,632.89

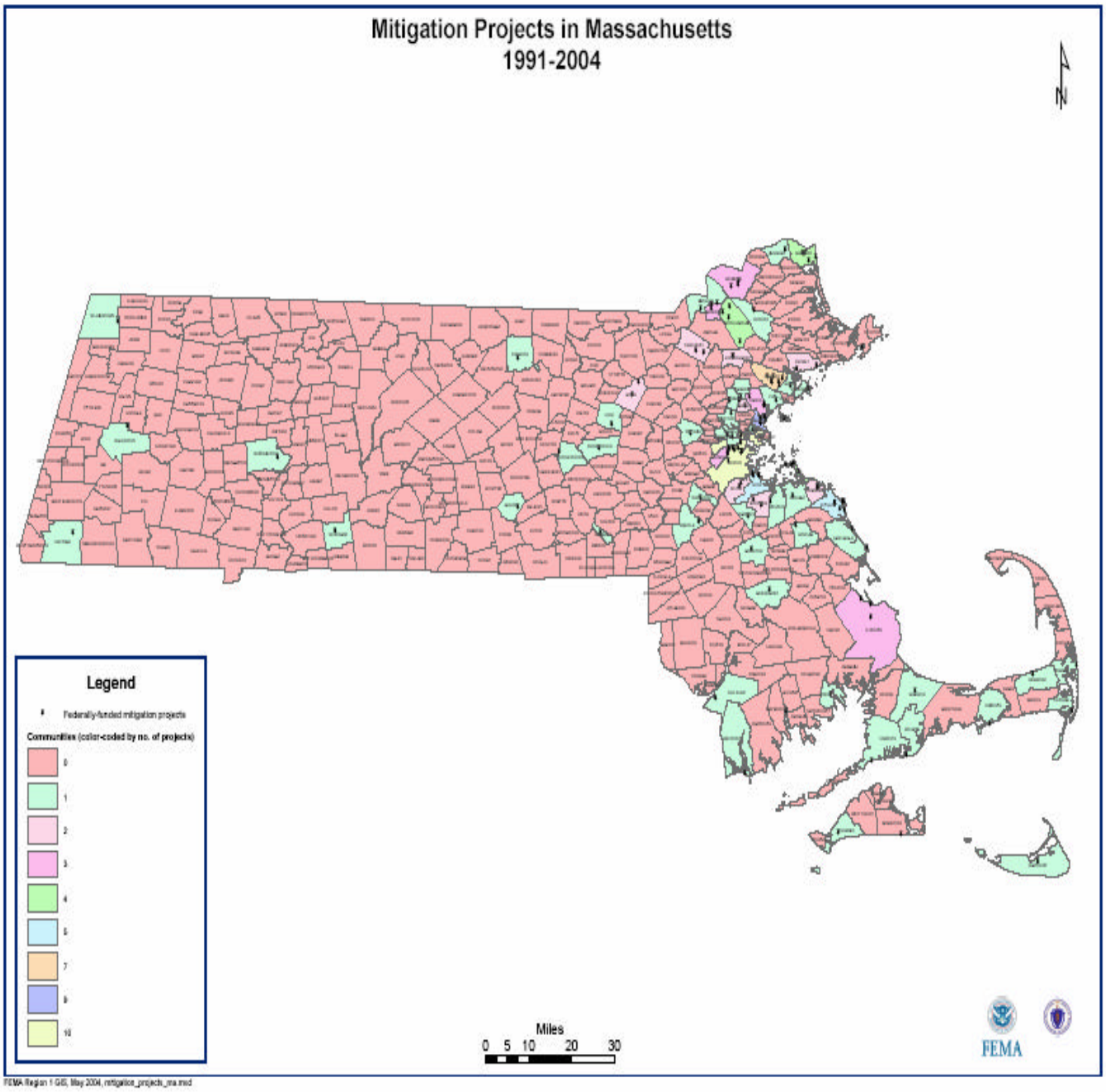
(May 1995)	(Public)	Monterey.			
DISASTER NAME (DATE OF EVENT)	**DISASTER # (TYPE OF ASSISTANCE)**	**DECLARED AREAS**	**FEDERAL SHARE DISBURSED**	**STATE SHARE DISBURSED**	**TOTAL DISBURSED TO DATE**
Russell/Montgomery Fire (Sept. 1995)	FEMA-2116 (Public)	Russell, Montgomery	$79,665.00	None	$79,665.00
	STATE (Public)	Russell, Blandford, Cummington, Huntington, Montgomery, Southampton	0	$100,000.00	$100,000.00
Jan. Blizzard (January 1996)	FEMA-1090 (Public)	All 14 Counties	$16,177,860.00	0	$ 16,177,860.00
May Windstorm (May 1996)	STATE (Public)	Counties of Plymouth, Norfolk, Bristol (27 communities)	0	$ 774,387.77	$ 774,387.77
Franklin County Rainstorm (June 1996)	STATE (Public)	Towns of Montague, Leverett, Shutesbury, Conway, Wendell, DEM, National Guard	0	$ 2,267,236.14	$ 2,267,236.14
October Flood (October 1996)	FEMA-1142 (Public)	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk	$ 21,547,025.97	$ 3,430,009.00	$ 24,977,034.97
	FEMA-1142 (Individual)	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk	$ 37,065,539.00	$ 478,072.00	$37,543,611.00
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)	$12,262,500.00	0	$12,262,500.00
(1997)	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk	$ 4,259,911.00	0	$ 4,259,911.00
June Flood (June 1998)	FEMA-1224 (Individual)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester	$20,034,025.00	$237,243.00	$20,271,268.00
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester (19 projects)	$1,769,145.00	0	$1,769,145.00
(1998)`	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester	$ 1,500,000.00	0	$ 1,500,000.00
Worcester Fire (December 3, 1999)	FEMA-3153 (Public)	City of Worcester, State Fire Mobilization Communities	$ 2,733,434.51	$ 875,703.59	$ 3,609,138.10
Tropical Storm Floyd (Sept. 16-17, 1999)	STATE (Public)	Counties of Hampden, Hampshire, Franklin, Worcester (23 communities)	0	$1,690,539.91	$ 1,690,539.91
June Rainstorm (June 25, 2000)	STATE (Public)	Towns of Adams, Cheshire, New Ashford, North Adams and Williamstown	0	$ 316,210.61	$ 316,210.61
July Rainstorm	STATE	Town of Heath	0	$ 180,000.00	$ 180,000.00

(July 15-16, 2000)	(Public)				
DISASTER NAME (DATE OF EVENT)	**DISASTER # (TYPE OF ASSISTANCE)**	**DECLARED AREAS**	**FEDERAL SHARE DISBURSED**	**STATE SHARE DISBURSED**	**TOTAL DISBURSED TO DATE**
March Flood (March 2001)	FEMA-1364 (Individual)	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester	$ 18,000,000.00	$ 213,039.00	$ 18,213,039.00
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester(16 projects)	$ 1,562,356.00	0	$1,562,356.00
March Blizzard (March 2001)	FEMA-3165 (Public)	Counties of Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk and Worcester	$20,742,629.36	0	$ 20,742,629.36
Aftermath TS Allison (June 17, 2001)	STATE (Public)	Towns of Hampden, Leominster, Monson, Princeton, Wilbraham	0	$635,534.00	$635,534.00
June/July Rainstorm (June 30-July 1, 2001)	STATE (Public)	Towns of Bellingham, Millis and Walpole	0	$254,968.02	$ 254,968.02
Terrorist Attack (Sept. 11, 2001)	FEMA-1391 (Individual)	Massachusetts residents who requested crisis counseling services following Sept 11th.	$1,500,000.00	0	$1,500,000.00
February Snowstorm (Feb. 17-18, 2003)	FEMA-3175-EM (Public)	All 14 Counties	$29,000,000.00	0	$29,000,000.00
December Snowstorm (Dec. 6 & 7, 2003)	FEMA -3191- EM (Public)	Counties of Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester	$22,877,000	0	$22,877,000
April Rainstorm & Floods (April 1 & 2, 2004)	FEMA -1512 (Individual)	Essex, Middlesex, Norfolk, Suffolk & Worcester Counties	$2,566,783	0	$2,566,783
		TOTAL DISBURSEMENT TO DATE:	**$271,900,659.84**	**$ 19,705,408.04**	**$265,962,284.88**

NOTE: Individual assistance funding includes loans and grants under the FEMA Disaster Housing, State IFG Program and/or SBA Home and Business Loan Programs.
Source: Massachusetts Emergency Management Agency, Disaster Recovery Division, Fall 2003

Location of Past & Current Hazard Mitigation Project Grants

Another indicator of vulnerability by jurisdiction to natural hazards, especially flooding, may be derived from where hazard mitigation projects have been funded. The following map gives an overview of where hazard mitigation grants have been distributed in Massachusetts since 1991. The source of the grant funding includes pre-disaster funding (FMA, PDM, Project Impact) and post-disaster funding (HMGP, CDBG). A complete listing of the communities, the grant type and amounts may be found in Appendix X.



5. Statewide Hazard Mitigation Strategy

The state must analyze what current programs, strategies and public policies address the impacts of natural hazards in order to develop a comprehensive hazard mitigation strategy for the future. With this knowledge, the state can determine the gaps in protection and incorporate appropriate solutions into this statewide plan. This section provides an overview of Massachusetts' current programs, policies and agencies which address natural hazards through hazard mitigation, followed by a brief overview of commonly used hazard mitigation measures in Massachusetts. These form the basis for Massachusetts' recommended hazard mitigation strategies, action steps, and potential resources to accomplish these identified tasks.

5.1 Implementing Hazard Mitigation in Massachusetts

The Commonwealth of Massachusetts has been committed to developing and implementing sound hazard mitigation measures to reduce the impact of natural disasters since 1978 when the state joined the National Flood Insurance Program (NFIP). As of 2004, 332 out of 351, or 95% of, Massachusetts communities participate in this important program. In addition, the Commonwealth has had a FEMA-approved State Hazard Mitigation Plan since 1986. The following chart outlines this history. FEMA approval correspondence may be found in Appendix C, State Interagency Hazard Mitigation Committee.

MA Hazard Mitigation Plan History 1986 – 2004

Year	*Plan Name*	*FEMA Approval*
1986	First State "409" Plan submitted to FEMA Region I for review and approval.	Yes
1989	State submits an update report on the state plan to FEMA for review and approval	Yes
1993	State updates and submits an updated of the State "409" Plan and the Hazard Mitigation Grant Program (HMGP) Administration to FEMA/Region I.	Yes
1998	State updates and submits an updated of the State "409" Plan and the Hazard Mitigation Grant Program (HMGP) Administration to FEMA/Region I for review and approval.	Yes
2000	State updates "409" Plan to include additional information from the June 1998 floods and submits plan to FEMA/Region I for review and approval.	Yes
2001	State and FEMA develop a short-term and long-term hazard mitigation strategy following the March 2001 Winter Storm and Floods.	Yes

Legal Framework for Implementing Hazard Mitigation

A number of different Massachusetts state agencies and offices conduct hazard mitigation as part of their organizational missions. The legal foundation for such hazard mitigation work is part of each agency's enabling legislation. Descriptions of each agency's hazard mitigation functions, including their enabling legislation, and current hazard mitigation measures can be found on the chart in Section 5.2, State Capability Assessment.

Several important pieces of legislation, including Executive Orders, in support of federal and state agencies' incorporation of hazard mitigation methods should be noted. For example, Federal Executive Orders 11988 and 11990, Floodplain Management and Protection of Wetlands, require that federal agencies avoid direct or indirect support of development in the floodplain and work to minimize harm to floodplains and wetlands. State agencies reviewing federally funded projects or receiving federal grants for projects must take these Executive Orders into consideration.

On the state level, Executive Order 149, State Coordination and Participation with the Federal Administration under the National Flood Insurance Act, designates the Massachusetts Water Resources Commission as the state agency to implement floodplain management programs within Massachusetts. Executive Order 181, Barrier Beaches**,** prohibits licensing development in velocity zones of primary dunes, as well as permitting of coastal engineering structures within barrier beaches. It also constrains the use of state funds and federal grants for construction projects that could encourage growth and development in barrier beach areas. Enacted in 1996, the Massachusetts Rivers Protection Act amends the Wetland Protection Act (MGL Chapter 131 Section 40) to provide protection to rivers, and implements hazard mitigation by regulating activities within a 200 foot wide resource area known as the Riverfront Area.

The State Board of Building Regulations and Standards (BBRS) administers the State Building Code which incorporates FEMA's National Flood Insurance Program Standards. As of the most recent edition of the State Building Code, these standards may be found under 780 CMR 3107.0 Flood Resistant Construction.

Lead State Agencies –

The Department of Conservation and Recreation (DCR)
The Massachusetts Emergency Management Agency (MEMA)

State Agency Partnership The Commonwealth of Massachusetts has a unique, statewide effort of interagency cooperation in the administration and management of its Hazard Mitigation Program. This program is a joint staffing effort between the Massachusetts Department of Conservation and Recreation (DCR) Flood Hazard Management Program (FHMP), which oversees the National Flood Insurance Program, and the Massachusetts Emergency Management Agency (MEMA) Disaster Recovery Division.

State Hazard Mitigation Team The team consists of the staff members employed by DCR and MEMA who work full-time on hazard mitigation planning, grants management and project management. The team is co-chaired by the State Hazard Mitigation Officer at DCR and the Disaster Recovery Manager at MEMA. The team meets on a monthly basis to coordinate team members' individual hazard mitigation work assignments and to give progress reports on statewide mitigation plans, mitigation projects, and technical assistance.

State Interagency Hazard Mitigation Committee This statewide committee consists of representatives of state and federal agencies, including the State Hazard Mitigation Team, that play key roles in implementing hazard mitigation programs, policies and projects throughout Massachusetts. The committee reviews policies, coordinates mitigation efforts and recommends recipients of hazard mitigation grants and assists in the development, implementation and, maintenance of the State Hazard Mitigation Plan. Following a

Presidential disaster declaration, this committee, in partnership with FEMA, serves as the Interagency Hazard Mitigation Team, or IHMT (per 44 CFR 206.401). Dependent upon the nature of that particular disaster, additional local, state and federal agencies may be asked to be temporary IHMT members by DCR, MEMA, and FEMA. If necessary, DCR, MEMA, and FEMA, within 7 days of the opening of the Disaster Field Office, will agree upon the date of the IHMT meeting and a timeline for the completion of the Early Implementation Strategy report. This meeting and report are tied into the annual update of the State Hazard Mitigation Plan.

The State Interagency Hazard Mitigation Committee includes the following agencies:

- MA Board of Building Regulations & Standards (BBRS)
- MA Coastal Zone Management (CZM)
- DCR Water Supply Protection
- DCR Waterways
- DCR Bureau of Fire Control
- DCR Office of Dam Safety
- DFW Riverways
- DEP Wetlands and Waterways
- MA Department of Housing & Community Development
- Woods Hole Oceanographic Institute
- Cape Cod Cooperative Extension
- National Fire Protection Association (NFPA)
- New England Disaster Recovery Information X-Change (NEDRIX – an association of private companies & industries involved in disaster recovery planning)
- MA Board of Library Commissioners
- MA Highway Dept.
- MA Division of Marine Fisheries
- MA Division of Capital & Asset Management (DCAM)
- MA Association of Regional Planning Agencies (MARPA)
- State Geologist, University of Massachusetts/Amherst
- Natural Resources Conservation Services (NRCS)
- MA Historical Commission
- U.S. Army Corps of Engineers
- Dept. of Homeland Security/Federal Emergency Management Agency

The chart on page 24 gives an overview of the State Interagency Hazard Mitigation Committee and the State Hazard Mitigation Team.

5.2 State Capability Assessment - Current Programs Supporting Hazard Mitigation

The following Massachusetts Capability Assessment is a summary of the state's hazard mitigation capability through a variety of state laws, regulations, authorities and agencies. This matrix includes current state laws, executive orders, regulations and policies and programs as well as related federal programs that currently support hazard mitigation through the Commonwealth. This assessment provides descriptions of each element; the elements' effect on loss and/or risk reduction and opportunities for new actions to enhance potential hazard mitigation strategies that will reduce future risks and losses due to natural hazards.

The most current information on all Massachusetts state agencies, including those listed throughout this matrix, may be found on the official Commonwealth of Massachusetts website at www.mass.gov.

Massachusetts Existing Hazard Mitigation Matrix

Emergency Management			
Type of Existing Protection	***Description***	***Effect on loss and/or risk reduction***	***Opportunities***
Civil Defense Act of 1950	Authorizes the creation of the Massachusetts Civil Defense Agency (predecessor to the Massachusetts Emergency Management Agency) and the development of a statewide civil defense program.	The Massachusetts hazard mitigation program is administered jointly by the Massachusetts Emergency Management Agency (MEMA) in coordination with the Department of Conservation and Recreation (DCR).	Allows for statewide coordination of resources from numerous state agencies and the private sector allows for more effective program.
MA Executive Order 144 and MA Executive Order 242	Amends and updates the Civil Defense Act of 1950 by creating the position of Secretary of Public Safety, coordinating emergency preparedness activities and the promulgation of a Comprehensive Emergency Response Plan for the state.	The Massachusetts hazard mitigation program is administered jointly by the Massachusetts Emergency Management Agency (MEMA) in coordination with the Department of Conservation and Recreation (DCR).	Hazard mitigation will continue to be a core mission of both MEMA and DCR.
MA Executive Order 149 and Chapter 21 of Massachusetts General Laws (MGL)	Executive order designates the Massachusetts Water Resources Commission (WRC) as the state coordinating office for the NFIP. Under MGL Chapter 21, the Department of Environmental Management (DEM) Division of Water Resources (DWR) serves as support staff for the WRC. In 1980, the Flood Hazard Management Program (FHMP) was created within DWR to be the NFIP coordinating office. DEM is now the Department of Conservation and Recreation (DCR).	Assist flood-prone communities in obtaining and maintaining participation in NFIP and assist property owners in making sound decisions related to flood insurance purchase and coverage.	Assist communities, permitting agencies and private individuals in ensuring that new development is constructed consistent with the NFIP requirements and sound floodplain management practices. Encourage flood mitigation activities that will reduce the risk of flood damage to existing property.

Hazard Mitigation Grants for Plans & Projects			
Type of Existing Protection	***Description***	***Effect on loss and/or risk reduction***	***Opportunities***
Hazard Mitigation Grant Program (HMGP)	Established pursuant to Section 404 of the Stafford Disaster Relief and Emergency Relief Act (PL 100-707), this program provides matching grants (75% Federal, 25% non-Federal) for FEMA-approved hazard mitigation projects following a Presidentially declared disaster. These grants are available to state, local and tribal governments as well as eligible non-profit organizations.	Allows for the completion of post-disaster mitigation projects that will reduce and/or eliminate losses due to natural hazards. Since 1991, following 6 Presidential disaster declarations, 101 hazard mitigation projects were constructed, using $17 million in federal funds and $7 million in non-federal funds. These projects could not have been completed without federal funding.	The data collected from the regional plans with local annexes will help the state to identify potential hazard mitigation strategies and projects before disasters occur. Completion of a FEMA-approved enhanced State Hazard Mitigation Plan could more the double the available HMGP funding.
Pre-Disaster Mitigation Program (PDM) Grants for Mitigation Planning and Projects	This all hazards mitigation grant program provides funding for hazard mitigation planning and projects. Originally allocated to states under a formula based on risk estimates, these matching grants (75% Federal, 25% non-Federal) for FEMA-approved hazard mitigation projects are now awarded through an annual national competition.	Provides critical funding for multi-jurisdictional plans with local annexes to be developed to help identify potential hazard mitigation projects as well as for mitigation projects. Since 2002, Massachusetts has received more than $500,000 to fund 7 regional planning agencies to develop regional and local hazard mitigation plans.	Ongoing federal funding is needed to continue Massachusetts' Statewide Mitigation Planning Strategy for the development of multi-jurisdictional plans with local annexes by regional planning agencies and participating communities. The state plans to apply for the necessary funding for the remaining 6 regional planning agencies to develop plans.
Flood Mitigation Assistance (FMA) Planning & Project Grants. Grants	Since 1997, this program has provided annual pre-disaster funding for developing local flood mitigation plans and corresponding flood mitigation projects on a cost-shared basis (75% Federal, 25% non-Federal). Program focuses on mitigation to NFIP repetitive loss properties.	Program is often the sole source of funding for flood mitigation plans and projects which have resulted in cost savings for communities and property owners. To date, Massachusetts has funded more than 15 plans and 7 projects.	Continued funding allows for ongoing focus on repetitive loss properties and complements current funding under the PDM and HMGP programs.

Hazard Identification & Mapping			
Type of Existing Protection	***Description***	***Effect on loss & risk reduction***	***Opportunities***
Massachusetts Statewide Mitigation Planning Strategy – regional and local risk analysis	The Commonwealth plans to partner with and fund multi-jurisdictional hazard mitigation plans with local annexes for all 13 Massachusetts regional planning agencies. These plans will include hazard identification and risk assessment and maps.	Provides regional and local risk assessment component for the statewide mitigation planning strategy.	This strategy will be continually evaluated and refined to develop the best risk assessment information.
Massachusetts Statewide Risk Analysis conducted for the state by Dewberry	Dewberry developed statewide natural hazard risk assessment and maps and analysis of state-owned facilities.	This analysis, completed in February 2004, has been incorporated into the State Mitigation Plan and shared with regional planning agencies and communities currently undertaking hazard mitigation plans.	New data from the multi-jurisdictional plans will assist in better identification of critical facilities and other structures which may be at risk to natural hazards. This data may be used by other state agencies as other plans are developed.
MA Coastal Zone Management (MCZM): Historic Shoreline Change Project	Provides 1:10,000 scale shoreline change maps that show the relative positions of four or five historic shorelines and depict the long-term change rate at 40-meter (approximately 131-foot) intervals along the shore.	Measures and estimates the changes in the state's coastline as a result of natural erosion and accretion as well as relative sea rise.	Assists in identifying potential areas and structures at high risk to coastal erosion and shoreline change. *Note: Additional information and words of caution on how to interpret this data is found in Appendix H, New England and Massachusetts Climatology or on CZM's website at www.mass/gov/czm*
MCZM & FEMA: Initiative to re-delineate Velocity (V) zone floodplain boundaries in four MA communities	This project is through FEMA's Cooperating Technical Partners (CTP) Initiative. Many coastal flood zones, as delineated on Flood Insurance Rate Maps (FIRMs), are outdated and need revision due to beach erosion/accretion and changes to the NFIP's regulatory V zone definition to include primary frontal dunes.	The completed delineation will be submitted to FEMA and their Flood Map Production Coordination Contractor for review, and once accepted, will be used to produce new FIRMs for the study communities.	The V Zone on these new maps will be significantly more accurate than those previous, and as such, these maps will better help property owners understand and mitigate the risks associated with this flood zone.
Massachusetts Map Modernization Business Plan	Developed by DCR as part of FEMA's nationwide program to update the maps of flood zones in most communities. Flood Insurance Rate Maps, or FIRMs, and the accompanying Flood Insurance Study (FIS) data are used in the administration of the minimum requirements of the NFIP.	Business plan includes a strategy and implementation schedule for the update of FIRMs throughout Massachusetts. Massachusetts cities and town rely heavily on the flood hazard information contained in the FIRMs and FIS for review of proposed development.	May help to increase the purchase of flood insurance and increase the public's awareness of flood prone structures and potential mitigation measures.
MA Coastal Zone Management (MCZM) Repetitive Flood Loss Structure Assessment	MCZM prepared maps of the Massachusetts Coastal Zone to delineate the location of repetitive loss structures. CZM identified correlations between high concentrations of repetitively damaged properties and a wide range of coastal processes parameters.	Identification of repetitive flood loss properties and correlations will assist in the development of better tools for coastal management and planning, such as purchasing flood insurance.	Assists in identifying areas at high risk from storm damage.

Public Safety			
Type of Existing Protection	***Description***	***Effect on loss & risk reduction***	***Opportunities***
State Board of Building Regulations & Standards/State Building Code (780 CMR)	Massachusetts State Building Code covers the entire state, applies to both public and private construction and is administered through the local building inspectors with state oversight. Section 3107 of the State Building Code contains most of the NFIP construction requirements related to buildings or structures.	NFIP standards are an integral section of the state building code, insuring that all new construction and substantial improvements meet national flood resistant standards. Many communities have enacted stricter standards under their local floodplain ordinances.	Allows for the application of NFIP standards on all new construction of buildings and structures throughout the state.
USDA-NRCS Emergency Watershed Protection Program	Provides technical and financial assistance to localities to reduce vulnerability of life and property in small watersheds damaged by severe natural events.	Allows immediate action to stabilize storm damages in streams following a federal declared natural disaster.	
Massachusetts Dam Safety Program, Ch. 330, Acts of 2002; 302 CMR 10	Inspects, registers, and provides grants for the repair of the 2,900 dams in the state.	Helps insure the structural integrity of dams thus preventing downstream flood loss.	Dams need continual inspection and maintenance schedules and continued funding of the federal, state and local agencies conducting this work is needed.
U.S. Army Corps of Engineers (USACE) constructed flood control projects, under state and local control and maintenance	Built by the U.S. Army Corps of Engineers, these structures (dams, dikes, seawalls and protection barriers) protect many cities in Massachusetts from riverine and tidal flooding. USACE assists the state and local governments in conducting annual inspections.	Since completion, these structures have prevented flood damages in major Massachusetts urban areas estimated at multi millions of dollars.	These structures require continual maintenance, which is a challenge to state and local governments. There may be future opportunities for the state and local governments to partner with USACE to continue ongoing inspections and repairs.
USDA-NRCS constructed PL 566 flood control dams, under state and local control and maintenance	32 small flood control dams that provide flood control to small watersheds in the mid and western sections of the state.	The state continues to inspect state-owned Pl 566 dams and provides flood protection to watersheds susceptible to high flood flow.	Dams need continual inspection and maintenance schedules. There may be future opportunities for the state and local governments to partner with NRCS to continue ongoing inspections and repairs.
Massachusetts Wildfire Program, MGL Chapter 48: Sections 8 through 28C	Carries out a comprehensive program of wildfire prevention, suppression and education through the state fire bureau and municipal forest wardens.	The primary vehicle to reduce losses from wildfire especially in developing areas known as the “wildfire urban interface” (WUI) where the new construction of buildings and structures in areas bordering, or in, forested areas prone to periodic wildfires.	

Public Safety (continued)			
Type of Existing Protection	***Description***	***Effect on loss & risk reduction***	***Opportunities***
State Fire Assistance; the Cooperative Forestry Assistance Act (PL 95-313), Volunteer fire Assistance and Federal Excess Property program	USDA Forest Service provides a wide range of grants to states for wildfire prevention, training and education programs; federal excess fire fighting materials; technical assistance and grants to communities with fewer than 10,000 population for forest fire related purposes .	Provides critical support to local wildfire prevention programs.	
Northeastern Forest Fire Protection Commission	Massachusetts is a party to mutual aid agreements with other state and provincial forest fire control agencies.	Enables Massachusetts to be able to call upon additional out of state resources to combat extreme conflagrations that may occur in Massachusetts.	
Massachusetts Fire Academy	The Massachusetts Fire Academy, operated by the Office of the State Fire Marshal, provides instruction on methods of fire suppression and specialized training to municipal fire fighters to qualify them for the U.S. Forest Service Red Card, which is required for deployment to any out of state fire.	Well-trained and educated firefighters for both structural fires and wildfires will more effectively, and safely, extinguish such fires as well as prevent future fires.	Firefighting staff, trained in wildfire mitigation techniques, can assist in fire prevention activities as well as public education efforts on an ongoing basis.
Fire Management Assistance Grant Program	The state annually signs an agreement with FEMA for this program under Section 420 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.	The state must have a signed and up-to-date FEMA-State Agreement and a Wildfire Management Plan before receiving federal funding under approved requests for Fire Management Assistance declarations.	See the 2004 Massachusetts Wildfire Management Plan in Appendix J.

Environmental Protection			
Type of Existing Protection	***Description***	***Effect on loss reduction***	***Opportunities***
EOEA: Massachusetts Environmental Policy Act (MEPA) MGL Ch. 30, Sec. 61-62h; 301 CMR 11.00	The main state environmental review process for state actions, projects with State funding, or projects requiring permits or licenses from state agencies.	Insures that major development projects being contemplated have considered applicable flood protection laws and regulations.	
DEP: Wetlands Protection Act MGL Ch. 131, Sec. 40; 310 CMR 10.00	Establishes state policy for protecting the state's wetlands by limiting development in wetlands and within a 100-foot buffer zone.	Limits new and expanded building in the state's coastal and inland wetlands.	
DEP: Rivers Protection Act; MGL Ch. 258-Acts of 1996; incorporated into 310 CMR 10.00	Establishes state policy for protecting the natural integrity of the Commonwealth's rivers and establishes open space along the rivers. The act regulates activities within the Riverfront Resource Area extending 200 feet from the edge of each bank.	Two of the eight interests promoted by this Act are providing flood control and storm water damage. This Act expands the area along the state's rivers in which flood control aspects of a proposed project are considered.	
MCZM: Inlands and Coastal Wetlands Restriction Acts (MGL Ch. 130, Sec. 105) and inland areas (MGL Ch.131, Sec. 40A)	Records at the Registry of Deeds restrictions on individual property deeds against future development of coastal wetlands on Cape Cod and some towns on the south coast and in the Charles River basin. The program now focuses on restoring wetlands.	Further protects critical coastal wetlands and barrier beaches from development.	Transferred to MCZM in order to allow for concentration on the protection of coastal areas.
Executive Office of Environmental Affairs: Community Preservation Act	Encourages cities and towns to undertake the purchase of open space to preserve natural resources.	Allows for the preservation of open space that also serves as flood storage areas. Plus, allows for the potential purchase of floodplains and wetlands to prevent future building of potential flood prone structures.	The state continues to provide technical assistance to participating communities as well as other communities interested in passing a local preservation act.
Coastal Development and Use-Chapter 91 Program; (MGL Ch. 91)	Protects the coastal tidal area for public open space purposes and regulates new and expanded construction within this area.	Further restricts development along coastal shores.	Reduces the amount of new development in high risk coastal areas that could be affected by coastal flooding, erosion and high winds.
DEP-Title 5/Septic System Management Title 5, (310 CMR 15):	Establishes minimum standards for the Subsurface Disposal of Sanitary Sewage. Enforced by DEP and local Boards of Health. Communities may adopt standards more restrictive than the state requirements.	Title 5 mitigates losses due to adverse effects of improper sewage treatment by strict requirements for placement and construction within high hazard flood areas.	Helps to minimize property damage as well environmental and health risks that could occur from improperly built septic systems in high hazard flood areas.
DEP Stormwater Management Program	Provides for all Massachusetts municipalities to prepare Phase II Storm Water Management Plans.	These plans directly address the major cause of flood damage loss in non-coastal communities in the state.	State continues to provide technical assistance for communities willing to prepare and adopt such plans.

Environmental Protection (continued)			
Type of Existing Protection	***Description***	***Effect on loss reduction***	***Opportunities***
MCZM Massachusetts Coastal Zone Management; (P.L. 92-583, Section 306)	Undertakes comprehensive coastal education and protection programs.	MCZM ensures that projects located in, or that affect the coastal zone, are in compliance with CZM enforceable programs.	Allows for additional opportunities to identify hazard mitigation measures to address coastal hazards, such as through the MA Coastal Hazards Committee.
MCZM: Executive Order 181, Barrier Beach Protection (1980)	This Massachusetts Executive Order discourages further development on barrier beaches by limiting state and federal funding for new support facilities, gives priority status for relocation assistance to storm damaged barrier beach areas; and encourages public acquisition of barrier beaches for recreational purposes.	Recognizes that human-induced changes to barrier beaches decreases the storm damage prevention and flood control capacities of these dynamic coastal areas.	Assists in reducing and/or limiting development in high risk areas for coastal flooding, erosion and high winds.
MCZM-State Rapid Response Storm Damage Assessment Team	The team consists of coastal planning and engineering experts who are "on call" to conduct damage assessment surveys of coastal areas immediately following storm events.	The team's damage assessments provide state and federal emergency managers with valuable information of coastal storm damages within several hours of a storm event thus allowing more focused response and recovery assistance.	This team continues to be utilized several times a year as coastal storm events occur.
State Sustainability Program, Executive Order No. 438, July 2002	This program helps state agencies minimize the environmental impacts of their operations and activities, and to promote innovative sustainable practices in Massachusetts.	By sustaining the environment and by implementing long-range planning, more hazard mitigation measures may be implemented throughout state agencies.	With tens of thousands of employees, hundreds of facilities, thousands of buildings and vehicles, and a multi-billion dollar budget, state government can achieve significant savings in energy, water, and materials use through greater efficiency and effective long-range planning.
EOEA –Land Acquisition/Open Space Program-	This effort allows the environmental agencies to acquire land for open space purposes to include outdoor recreation, promoting biodiversity and protecting the natural resources of the Commonwealth.	Directly promotes flood water retention and flood loss reduction by preserving many critical parcels along the coast and rivers of the Commonwealth as open space.	This program continues to receive funding from the state capital funding plans.
Massachusetts Climate Protection Plan – Office of Community Development	This plan is an initial step in a coordinated effort to reduce the affects of climate changes, such as reduction in the emission of greenhouse gases and improve energy efficiency.	Many of the protection measures to alleviate climate impacts also bring with them significant other benefits. Such actions will help the economy, protect natural resources and preserve the quality of life in Massachusetts.	Continued coordination and cooperation is needed between the more than 15 agencies involved in the plan.

Cultural & Historical Resources			
Type of Existing Protection	***Description***	***Effect on loss reduction***	***Opportunities***
MHC: National Historic Preservation (NHPA) Act of 1966 (36 CFR Part 800 – Protection of Historic Properties)	Massachusetts Historic Commission administers the NHPA Section 106 review process for all proposed hazard mitigation projects submitted to the federal government under the HMGP, FMA and PDM programs. Properties subject to Section 106 review include all properties listed on the National Register of Historic Places and all properties believed to be eligible for listing in the National Register.	Insures that FEMA-funded mitigation projects achieve loss reduction while preserving the historic integrity of the listed properties. Administered through the Massachusetts Historic Commission (MHC). Close coordination is facilitated through the MHC director being a member of the State Hazard Mitigation Interagency Committee.	By focusing on cultural resources, hazard mitigation will reduce future economic, cultural and historical losses which are vital to many Massachusetts communities. Also, ensures that new hazard mitigation projects will not adversely damage cultural and historic sites.
MBLC: Emergency Assistance Program for Massachusetts Libraries	The Massachusetts Board of Library Commissioners administers a grant program for libraries to undertake flood loss prevention actions.	One staff person works full time on mitigation activities, and MBLC provides an important source of funds for mitigation actions.	This program continues to provide technical assistance on an as needed basis to many communities throughout the state.
MBLC: Interagency Cultural Resources Committee	This committee of several government agencies and cultural institutions promotes education and technical assistance projects to enhance the protection of cultural resources from natural disasters.	Massachusetts's cultural resources are often stored in basements susceptible to flooding. This committee promotes pro-active steps to reduce losses from natural hazards, especially floods or water damage following fires. .	This committee restarted in 2004 to focus on the Boston/Metro area after a three year hiatus. Meets on a regular basis to further identify hazard mitigation needs and funding opportunities for cultural and historical institutions.

Technical Assistance			
Type of Existing Protection	***Description***	***Effect on loss reduction***	***Opportunities***
MA State Mitigation Team at DCR & MEMA	A cooperative program between two state agencies which has been in existence since 1993. Allows for the sharing of staff and agency resources in support of state and federal hazard mitigation programs.	Both agencies work cooperatively in providing hazard mitigation grants and project management, especially ongoing technical assistance, to communities, regional planning agencies and other state and federal agencies participating in mitigation programs statewide, especially the Pre-Disaster Mitigation Program (PDM), the Hazard Mitigation Grant Program (HMGP) and the Flood Mitigation Assistance Program (FMA).	The state continues to provide technical assistance on hazard mitigation grants and projects on an as needed basis with a recent focus on working with regional planning agencies throughout the state to complete the Statewide Hazard Mitigation Planning Strategy (See Section 2).
DCR: Floodplain Management Services (FPMS) and Section 22 Planning Assistance to States Program.	US Army Corps of Engineers provides floodplain management and water resources technical assistance to states. This program is coordinated in Massachusetts by the Department of Conservation and Recreation and the Water Resources Commission.	Provides a continuing source of technical assistance for flood loss reduction plans and projects.	The state continues to provide information and technical assistance to communities to help identify potential projects that would qualify for funding.

Other Programs			
Type of Existing Protection	***Description***	***Effect on loss reduction***	***Opportunities***
U.S. Department of Housing and Urban Development (HUD)	In 1997 and 1998, additional funding for hazard mitigation projects became available under HUD's Community Development Block Grant Disaster Recovery Initiative (DRI).	This grant, administered in a partnership between MEMA, DEM and Massachusetts Department of Housing and Community Development, allowed for the completion of 13 hazard mitigation projects since 1997.	
U.S. Geological Survey (USGS)	USGS researches the processes that control or trigger natural hazards and manages real-time river flood stage monitoring and warning systems. USGS maintains 71 stream-gauging stations in cooperation with DCR and DEP. USGS is currently assisting in the installation of stream gauges in smaller urban rivers throughout Massachusetts.	Real time river flood stage monitoring is essential for the operation of flood response plans.	The state continues to partner with USGS and is seeking ways to enhance the use of USGS gauges for early storm/flood warning systems.

5.3 Mitigation Measures and Projects

Implementing effective hazard mitigation in high risk areas in the Commonwealth involves several approaches. These approaches may be categorized in two major areas: non-structural and structural hazard mitigation measures, or projects. In support of the efforts by municipalities, organizations, businesses and private citizens to reduce damages after natural disasters, the Commonwealth's Hazard Mitigation Program emphasizes the use of a ***non-structural*** hazard mitigation approach before undertaking a ***structural*** approach (see following definitions). Massachusetts places a higher priority on funding non-structural projects. Although some non-structural hazard mitigation measures may be lower in cost (i.e. institution of a floodplain ordinance), such measures may be very time intensive in terms of staff time and take several years to implement.

Non-Structural Hazard Mitigation Measures & Projects

A <u>non-structural hazard mitigation approach</u> is a strategy that does not change the natural hazard, but involves preventative actions that improve infrastructure to reduce the damages, or improve coordination of resources. Again, Massachusetts places a priority on funding non-structural projects

Some examples of non-structural projects include:

- Building & Construction Design (Massachusetts State Building Code)
- Enforcement of Building Codes
- Improvements to Existing Flood Control Structures
- Planning and Zoning
- Open Space Preservation & Wetlands Protection
- Floodplain Development Management (subdivision regulations, erosion control bylaws, floodplain ordinances)
- Stormwater Management
- Relocation
- Acquisition
- Building Elevation
- Floodproofing (barriers, dry flood proofing, wet flood proofing, elevation of essential utilities)
- Sewer Backup Protection Insurance
- Erosion and Sediment Control

- Beach Nourishment (through natural methods such as the placement of snow fencing and the planting of beach grass)
- Best Management Practices
- Weather Forecasting
- Emergency Measures (Comprehensive Emergency Management Plans for each community)
- Public Information (flood map information, outreach projects, real estate disclosure, technical assistance, education programs)

Structural Mitigation Measures & Projects

A **structural approach** involves measures used to prevent a natural hazard, such as floods, from reaching property. These measures are "structural" because they involve construction of man-made structures to control a hazard, such as construction of a dam or sea wall to control water flow. Most structural projects can be very expensive and have other shortcomings, such as: destruction of natural habitats by disturbing the land and natural water flow, increased erosion to adjacent unarmored shorelines or river banks; causing extensive damage when built to a certain flood protection level, but then are exceeded by a larger flood and require continuous and high cost maintenance. Examples of structural measures include dikes, drainage modifications, dams and seawalls.

Over the past decade as hazard mitigation project funding became available to Massachusetts; the Commonwealth realized the high cost and maintenance in building any new structural hazard mitigation projects. While the Commonwealth's Hazard Mitigation Program emphasizes the use of non-structural approaches over structural approaches, the density of at-risk development in some areas combined with the high value of existing mitigation infrastructure (e.g., seawalls, drainage systems) at times makes it more cost-effective to upgrade existing structures to provide added levels of protection. In such cases a limited structural approach (e.g., upgrading an existing seawall or culvert) may be preferable to a non-structural approach.

Hazard Mitigation Project Eligibility in Massachusetts

The state has had a FEMA-approved Hazard Mitigation Grant Program (HMGP) Administrative Plan since 1986 which details the process for prioritizing local assistance through post-disaster mitigation funding of local mitigation projects. Massachusetts has also used similar criteria to prioritize local pre-disaster mitigation assistance from the Flood Mitigation Assistance (FMA) from 1997 to present as well as the Pre-Disaster Mitigation (PDM) programs from 2002 to present.

The following criteria for prioritizing local assistance for hazard mitigation grants are found in the State Grants Administration Plan (complete text of this plan is found in Appendix K):

Eligible projects for pre-disaster and post-disaster hazard mitigation funding in Massachusetts must meet the following criteria:

1) Must be included in a FEMA approved local and/or multi-jurisdictional all-hazards mitigation plan which meets the mitigation planning requirements per the Disaster Mitigation Act of 2000 (*this guideline become effective Nov. 1, 2004).*

Elevated home in Tewksbury, MA, funded through the Flood Mitigation Assistance (FMA) program.

2) Must conform to the suggested hazard mitigation measures outlined in the Massachusetts State Hazard Mitigation Plan developed as a requirement of the Disaster Mitigation Act of 2000. These measures include a priority placed on local mitigation projects that involve: **non-structural, or "low cost" solutions** (i.e. updating and enforcing local flood ordinances); **retrofitting high-risk structures** (i.e. elevating residences in coastal flood zones) and the **acquisition of repetitive loss** storm-damaged structures.

3) Must be located in, or have a beneficial impact upon, past declared disaster areas; or in a high risk area for potential impacts from one or more natural hazards, such as a floodplain, high wind area, coastal zone, etc. This high risk area should be identified in either the local, regional or state mitigation plan.

4) Must be in compliance with all existing Massachusetts Laws and Regulations for construction, land alterations, and natural resource protection, such as the Massachusetts State Building Code, the Massachusetts Wetlands Protection Act and Regulations, the Massachusetts Wetlands Restriction Act, and the Massachusetts Coastal Zone Management Policies;

5) Must be in compliance with municipal ordinances and zoning regulations;

6) Must be in conformance with 44 CFR, Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR, Part 10, Environmental Considerations;

7) Must provide a solution to a problem independently, or provide a significant functional portion of a solution being addressed in a combined project. If the project constitutes a significant functional portion of a solution being addressed, the status of any associated dependent or supporting projects must be given. There must be reasonable assurance that the total mitigation project will be completed. The identification or analysis of a problem does not automatically qualify for eligibility;

8) Must meet FEMA's cost-effective criteria such as the need to substantially reduce the risk of future damage, hardship or losses resulting from a major disaster. Documentation will be required that demonstrates that:

   i) The problem is repetitive and/or poses a significant risk if left unsolved. Therefore, a brief history of previous occurrences of the problem at the project location, including dates and impact of each event, and/or an analysis of projected potential damages if the project is not completed must be given.

ii) Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.

iii) Documentation comparing the proposed project to alternatives considered, including non-structural approaches.

iv) The proposal has been determined to be the most practical, effective, and environmentally sound alternative found after consideration of all available options.

v) The project contributes to the long-term solution of the problem it addresses. Therefore, an estimate of the effective life of the project and a listing of influence factors should be included.

vi) Development of the project considers any long-range alterations to the area and the entities that it protects, has future maintenance requirements that are financially feasible and can be modified, if necessary, without changing the impact on the area.

Hazard Mitigation Project Selection

Available federal funds for pre-disaster and post-disaster hazard mitigation assistance will most likely not be sufficient to support all eligible project applications. An attempt will be made to award grants to the maximum number of eligible projects. Recommendations for funding will be made by the Massachusetts State Interagency Hazard Mitigation Committee and the State Hazard Mitigation Team to the regional FEMA office, and FEMA will make the final selection of grants to be awarded. The mitigation measure proposed should not be intended to replace what was damaged only, but rather should provide more protection to life and property than what existed prior to the storm.

The proposals will be evaluated and prioritized by the Massachusetts State Interagency Hazard Mitigation Committee and the State Hazard Mitigation Team according to the following criteria.

1) Measures that best fit within an overall plan for development and/or hazard mitigation in the community, disaster area, or State, especially those described in a local and/or multi-jurisdictional mitigation Plan. Massachusetts sets priority on non-structural solutions, storm damaged structure/property acquisition efforts, and plans that promote retrofitting flood prone structures and overall environmental protection. Equipment purchases will be a low priority unless demonstrated to be an integral part of an overall hazard mitigation plan.

2) Measures that, if not taken, will have a severe detrimental impact on the applicant, such as loss of life, loss of essential services, damage to critical facilities, or economic hardship on the community.

3) Measures that have the greatest potential impact on reducing future disaster losses. Measures must have a demonstrated ability to solve the problem. They cannot merely analyze or identify hazards and problems.

4) Projects designed to protect and/or improve the environment while reducing damage potential.

5) Projects that have maximum local support, a high level of interest and commitment by the applicant.

6) Applicant has technical ability to successfully implement the project in a cost-effective manner.

7) Projects that enhance environmental protection; at a minimum, projects must meet all local, state, and federal environmental standards, and not require a variance to state environmental regulations.

8) Projects involving public/private partnership.

Upon completion of local and multi-jurisdictional plans, local hazard mitigation assistance will be based in part on the risk assessments, project recommendations and benefit cost analyses described in these plans. The MA Grants Administration Plan is found in Appendix J.

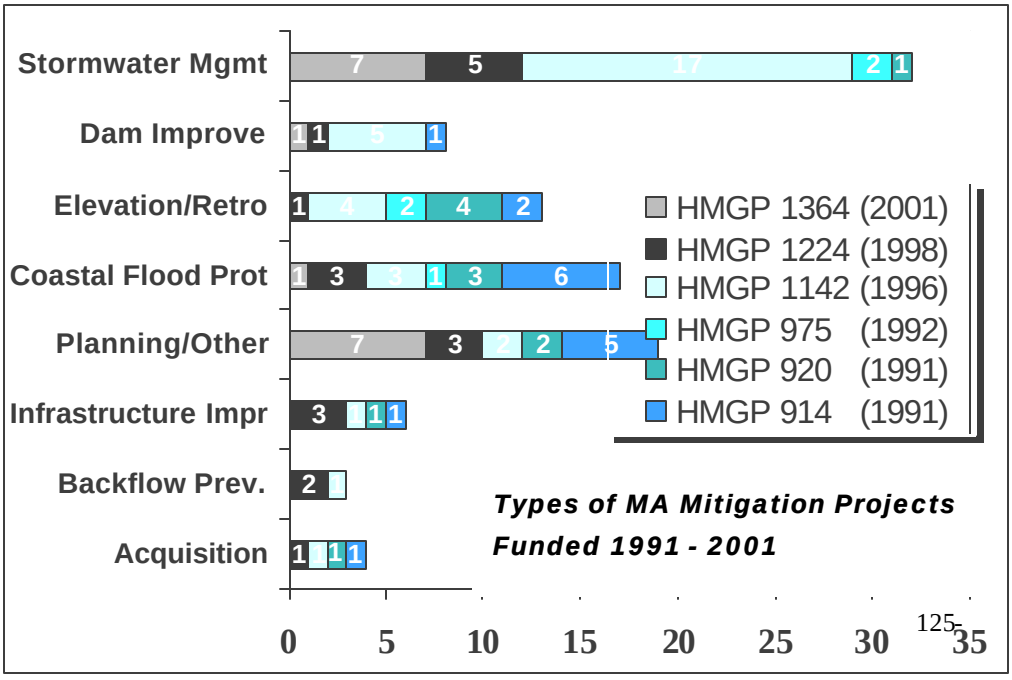
Tracking Past Hazard Mitigation Measures & Projects

Since 1991, Massachusetts has been able to support 161 hazard mitigation projects and plans with over $25 million in federal funding from both pre-disaster and post-disaster hazard mitigation grant programs (see summary chart below). Several tables on the following pages provide additional breakdowns of funding sources and number of projects or plans. In addition, the map found in Section X shows the geographic location of hazard mitigation projects throughout the Commonwealth.

Time Period	*Federal Program*	*Total Projects or Plans*	*Total Federal Dollars*
1991 – 2001	Hazard Mitigation Grant Program (HMGP) Projects	101	$16,959,709
2001	Hazard Mitigation Grant Program (HMGP) Plans	3	$87,463
1997 - 98	Housing & Urban Development/Disaster Recovery Initiative	13	$5,759,911
1997 - 2003	Flood Mitigation Assistance Program (FMA) Project Grants	15	$1,994,610
1997 - 2003	Flood Mitigation Assistance Program (FMA) Planning Grants	18	$217,635
2002 - 04	Pre-Disaster Mitigation Planning Grants	8	$741,602
	Total	***161***	***$25,760,930***

Massachusetts Mitigation Tracking Database

In 1999, the State Mitigation Team developed a comprehensive database to track and monitor all open and completed hazard mitigation project and planning grants funded under the HMGP, FMA, HUD and PDM programs. This program has allowed the Commonwealth to track and monitor project and plan



timelines and completion dates. This database allows the state to track projects and plans by a specific grant program, by community, by project type, by project cost balances and other related data. For instance, this database allows for tracking by project type, such as dam improvements, stormwater management, elevation etc (see above chart).

A report from this database, which summarizes all the current and completed hazard mitigation projects in Massachusetts since 1991, may be found in Appendix K. The following section on Hazard Mitigation Success Stories highlights several of the completed and test mitigation projects.

Hazard Mitigation Project Success Stories in Massachusetts

Many hazard mitigation projects were completed in the late 1990s; the true test of several new projects came in March 2001 following a severe early spring snowstorm and coastal flooding event. A Presidential disaster declaration was issued in April 2001, and again, in March 2004, for eastern Massachusetts. The State Mitigation Team, in coordination with FEMA's Hazard Mitigation Officer for the disaster relief operation, utilized available national disaster operations staff to make site visits to completed mitigation projects throughout eastern Massachusetts.

During these two disaster relief operations, FEMA staff was able to compile two newsletters which document successful hazard mitigation projects throughout an area with frequent flooding. In addition, the state published a Mitigation News newsletter in February 2004. Copies of these three newsletters and more success stories may be found in Appendix L.

MA Mitigation Success Story

Belmont Debris Threat Removed

Before and after views of the Wellington Brook culvert grate show the improvements to handle high water volume.

During every heavy rainstorm, the inlet of Wellington Brook culvert became clogged with debris and overflowed. The makeshift grate over the inlet created this problem - flooding surrounding neighbor-hoods, basements, yards, a parking lot and swimming pool.

Belmont officials realized something had to be done to correct the situation. The Town of Belmont applied for HMGP funding in January 2002 to replace the existing grate with an engineered grate designed to allow high water flows to enter the culvert from all directions. The entrance to the culvert was also rebuilt to better direct and contain the water flow into the culvert.

This mitigation project was completed in early 2004 and had no problem handling the floodwaters from Wellington Brook during the severe rainstorms of April 1-2, 2004. David Frizzell, Belmont Emergency Management Director, Director, emphasizes that the improved grate works well and the Town is quite happy with the results.

Regional Multi-Jurisdictional & Local Hazard Mitigation Plans

As part of the Commonwealth's statewide planning strategy to meet the multiple hazard mitigation planning goal of DMA 2000, the regional planning agencies (RPAs) in Massachusetts, will be developing specific regional hazard mitigation strategies and identifying specific mitigation measures, such as non-structural measures and projects that address the highest natural hazard risks within their regions.

Four regional planning agencies – the Cape Cod Commission (CCC), the Franklin County Council of Governments (FRCOG), the Metropolitan Area Planning Council (MAPC) and the Southeastern Regional & Economic Development District (SRPEDD) – received funding from the Commonwealth in 2002 through the Pre-Disaster Mitigation Program to complete regional hazard mitigation plans with municipal annexes. In 2003, the Commonwealth funded three more RPAs – the Berkshire Regional Planning Commission (BRPC), the Northern Middlesex Council of Governments (NMCOG), the Old Colony Planning Commission (OCPC) – to complete regional and local mitigation plans. These plans will be completed by mid-2005. The remaining six RPAs in Massachusetts will be funded through future PDM funding for mitigation plans. In 2002, 3 communities, Framingham, Marblehead, and Melrose, received planning funds from the HMGP program from the April 2001 disaster declaration. These communities will have their multi-hazard mitigation plans completed by the end of 2004.

As these plans are completed and submitted to the Commonwealth for review and approval, the regional and local hazard mitigation measure will be incorporated into this section of the State Hazard Mitigation Plan. These measures will be reviewed and analyzed by the State team of DCR and MEMA staff as well as the State Hazard Mitigation Interagency Committee - in order to identify any trends and issues related to these proposed hazard mitigation measures. Dependent upon future funding, the Commonwealth will provide the participating RPAs and communities with technical assistance as needed for the implementation of cost effective hazard mitigation measures. It is expected that this section of this plan will be updated with input from the local and regional plans

MA Hazard Mitigation Success Story

Culvert Upgrade Protects Neighborhood

"The Sumner Street Culvert passed with flying colors. We received about 4.2 inches of rain during the last storm. Typically, the culvert would have failed in an event like this, but we had absolutely no problems." This is how Mark P. Ryan, Norwood Town Engineer described the effectiveness of a recently completed Hazard Mitigation Grant Program (HMGP) project in his town. HMGP funding enabled replacement of an undersized culvert that carried Traphole Brook under Sumner Street with twin concrete box culverts. On April 1-2, 2004 over 4 inches of rain was recorded and the replacement culvert worked exceptionally well.

The old stone culvert had caused numerous flooding incidents. During even moderate rainstorms, the swollen brook would overwhelm this pipe, causing 11 homes and properties to be flooded. In June 1998, floodwaters completely washed out Sumner Street and forced its closure, until the culvert and roadway could be repaired.

"The twin 4 foot by 9 foot culvert was, at most, half full. Therefore, there was no roadway topping and the upstream properties were not flooded due to backwater. A definite success story," said Mr. Ryan.

5.4. Statewide Goals, Strategies & Action Steps

This section of the plans provides a list of Massachusetts' strategies and action steps to implement a comprehensive hazard mitigation program over the next three years. These strategies and action steps as well as the statewide goal are based on the data provided in the previous sections of the plan, especially the risk and vulnerability assessment and the current hazard mitigation program matrix.

Statewide Goal: *Reduce the statewide loss of life, property, infrastructure, and cultural resources from natural disasters through a comprehensive hazard mitigation program which involves planning, prevention and preparedness strategies.*

Massachusetts Mitigation Strategy

PLANNING						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
1. Meet the planning requirements for hazard mitigation plans contained in the Disaster Mitigation Act of 2000.	(A). Complete a standard State Hazard Mitigation Plan and submit for FEMA review and approval prior to the Nov. 1, 2004 deadline per DMA 2000.	MEMA & DCR	Current	Current MEMA/DCR staff; EMPG funds	Required by DMA 2000 planning regulations.	A FEMA-approved State Mitigation Plan is needed to continue to implement the Statewide Mitigation Planning Strategy, and continue the availability of disaster assistance and hazard mitigation grants.
	(B) Complete an Enhanced State Mitigation Plan.	MEMA & DCR	3 years	Current MEMA/DCR staff; EMPG funds	To qualify for an increase in available HMGP funding from 7.5% of disaster assistance costs to up to 20% of disaster assistance costs.	Additional HMGP funding will support implementation of more hazard mitigation projects as identified in the state, regional and local hazard mitigation plans.

PLANNING (CONTINUED)						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
	(C) Provide technical assistance to the 7 regional planning agencies currently receiving funding to complete, review and implement multi-jurisdictional "all hazard" mitigation plans with local annexes.	MEMA & DCR	2 years	PDM, HMGP, FMA planning funds from 2002 & 2003; DCR/MEMA staff	Regional planning agencies bring local and regional planning expertise, knowledge and contacts, especially in transportation issues and land use planning, to the mitigation planning process.	FEMA-approved local mitigation plans are needed to continue to implement the Statewide Mitigation Planning Strategy, and continue the availability of hazard mitigation grants to communities.
	(D) Partner with the remaining 6 regional planning agencies in Massachusetts over a three-year period to develop and implement regional and local "all hazards" mitigation plans.	MEMA & DCR	3 years	PDM-C, HMGP and FMA planning funds for 2004, 2005 and future years.	Regional planning agencies bring local and regional planning expertise, knowledge and contacts, especially in transportation issues and land use planning, to the mitigation planning process.	FEMA-approved local mitigation plans are needed to continue to implement the Statewide Mitigation Planning Strategy, and continue the availability of hazard mitigation grants to communities.
	(E) Apply for available federal funding to implement and update the completed and approved multi-jurisdictional and local hazard mitigation plans.	MEMA & DCR	3 – 7 years	Future PDM-C, HMGP & FMA funding from 2005 - 2010	Obtain maximum available funding to implement identified mitigation projects.	Federal mitigation grant funding is a key component to support implementation of hazard mitigation projects as identified in the state, regional and local hazard mitigation plans.
	(F) Incorporate new data and recommendations from the FEMA-approved regional and local mitigation plans into the State Mitigation Plan, especially new data on critical facilities locations throughout the state.	MEMA & DCR	3 years	Current MEMA/DCR staff	Analyze regional and local data and recommendations and to update the state plan.	Will assist the state in compiling up-to-date lists of prioritized hazard mitigation projects and actions throughout the state.

PLANNING (CONTINUED)						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
	(G) Track potential hazard mitigation projects and strategies statewide in a database, using new information provided by the multi-jurisdictional plans with local annexes.	MEMA & DCR	3 years	Current MEMA/DCR staff to adapt current mitigation project database	To develop a statewide database of potential hazard mitigation projects and strategies that support of the goals and objectives of the completed mitigation plans.	Will assist the state, RPAs and participating communities in applying for appropriate grants and meeting mitigation goals outlined in completed mitigation plans.
	(H) Coordinate data collection and sharing with other statewide planning initiatives, such as the Statewide Homeland Security Planning process.	MEMA, DCR, Executive Office of Public Safety (EOPS) staff	Ongoing	Current MEMA, DCR, EOPS staff	Combining resources will allow for more accurate information in several statewide plans.	Coordination of data collection methodology and new information will allow for a more accurate statewide plans and maps.
	(I) Continue to support existing statewide mitigation planning, especially the Community Assistance Program-State Support Element (CAP-SSSE) Floodplain Management Plan, in order to carry out a full range of assistance activities under the National Flood Insurance Program, and the Map Modernization Business Plan, to insure updates of flood maps statewide.	DCR's Flood Hazard Management Program (FHMP) staff	Ongoing, annual plan	CAP-SSSE funding; Map Modernization Management Support (MMMS) funding; FHMP staff	Support of current statewide mitigation programs such as the National Flood Insurance Program and the Map Modernization Program will allow for more accurate flood risk assessment and the implementation of appropriate mitigation measures, such as the purchase of flood insurance.	Ongoing and improved compliance with the NFIP, in conjunction with the Map Modernization Program, will allow the state to focus its resources, such as technical assistance and mitigation grants, in the highest flood risk communities.

PREVENTION						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
1. Increase awareness of the cost-savings and public safety benefits of hazard mitigation projects.	(A) Develop and implement a statewide hazard mitigation program, including educational materials, for federal and state agencies.	MEMA & DCR & members of State Mitigation Interagency Committee	Ongoing	Hazard mitigation admin and technical assistance funds	Better informed agencies will help identify other resources and other potential mitigation projects & actions.	Greater awareness among state and federal agencies will reduce the risks to natural hazards by allowing for more effective implementation of the strategy, especially the completion of mitigation projects & actions.
	(B) Conduct ongoing hazard mitigation community outreach and educational programs for the general public, such as programs in schools and at home improvement stores and events.	MEMA & DCR & members of State Interagency Committee	Ongoing	Hazard mitigation admin and technical assistance funds	A better informed public will allow for people to take action before a disaster to reduce their risk.	Educated consumers will be better protected from natural disasters because they have reduced risks by implementing various hazard mitigation techniques, projects and actions.
	(C) Continue to hold hazard mitigation grant workshops for state agencies and local governments after natural disasters, especially immediately following Presidential Disaster Declarations.	MEMA & DCR	Within 2-3 months of disaster declaration	Hazard mitigation admin and technical assistance funds	Informed public officials will apply for funding for hazard mitigation projects as well as motivate communities without plans to develop hazard mitigation strategies.	Informed local officials will apply for funding for hazard mitigation projects and actions that will help to reduce future risks.
	(D) Better utilize new Internet-based technology to develop more consistent and timely tools for distributing information about current hazard mitigation programs and success stories in Massachusetts to other government agencies, the private sector, and the general public.	MEMA & DCR	Ongoing	Hazard mitigation admin and technical assistance funds	Informed public officials will apply for funding for hazard mitigation projects as well as motivate communities without plans to develop hazard mitigation strategies.	Informed local officials will apply for funding for hazard mitigation projects and actions that will help to reduce future risks.

PREVENTION (CONTINUED)						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
2. Increase coordination and cooperation between state agencies in implementing sound hazard mitigation planning and project development	(A) Continue to make recommendations to the Board of Building Regulations and Standards (BBRS) as the MA State Building Code is updated to include updated National Flood Insurance Program (NFIP) Standards and other building standards related to natural hazards, such as wind, snow and seismic loads.	MEMA, DCR, BBRS	Ongoing, as needed (dependent on Building Code update schedule)	MEMA, DCR staff	The inclusion of revised federal mitigation standards in the State Building Code will allow for consistent implementation of sound mitigation measures statewide, especially in new construction and in the repair/renovation of substantially damaged structures.	Allows for uniform application of mitigation measures by local officials.
	(B) Encourage project granting agencies in the state, such as the MA Department of Housing and Community Development's review of Housing and Urban Development's Community Development Block Grant Program and the State Office of Community Development, to include the analysis of downstream flood impact when reviewing applications for funding.	State Inter-agency Committee	3 years	MEMA, DCR staff	By avoiding the building of new structures within an area of potential downstream flood impacts, this coordinated action between agencies will reduce, or mitigate, future damages and costs following future flood events.	By decreasing the potential downstream impacts of flooding on new structures, will decrease potential exposure to flood risks and the additional costs associated with re-building following a flood event.
	(C) Participate in the new State Coastal Hazards Management Steering Committee mandated by Massachusetts state legislation (Chapter 236 of the Acts of 2002 – MA Senate No. 2319) which will focus on specific solutions to coastal hazards.	CZM, MEMA, DCR	Ongoing	MEMA, DCR staff	This committee will examine innovative mitigation solutions specific to coastal hazards and will allow for additional input from other state agencies, elected officials and the general public in developing appropriate strategies for coastal communities.	This committee is required by state law to develop a coastal hazards management plan, including coastal hazard mitigation strategies as well as legislative and funding recommendations. This plan will complement the State Mitigation Plan.

PREVENTION (CONTINUED)						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
	(D) Recruit additional state agencies involved in the review and permitting process to participate on the State Interagency Committee on a regular basis.	MEMA, DCR	2 years	MEMA, DCR staff	Active participation of state agencies in the Interagency Committee will facilitate the sharing of information between agencies and expedite implementation.	Increasing coordination and cooperation between state agencies will insure more widespread and consistent implement of sound hazard mitigation measures throughout the state.
	(E) Continue working with other state agencies, especially those on the State Interagency Committee, to ensure that all the necessary permits and requirements are being met before the execution of all hazard mitigation projects through the PDM, HMGP and FMA programs.	MEMA, DCR, State Interagency Mitigation Committee	Ongoing, especially within 3 months following a Presidential disaster declaration	MEMA, DCR staff, State Grants Administration Plan	By coordinating all the necessary federal and state permits, the state will avoid future problems as projects are constructed.	Coordination of the permits and other requirements ensures a timely completion of an effective hazard mitigation project.
3. Work with the appropriate state and federal agencies to maintain and repair high hazard dams in the state, including preparation of Emergency Action Plans (EAPs).	(A) Based on the development of an updated inventory of high hazard dams, develop a list of high priority dams that are in the greatest need of repair and that have the greatest impact in the event of a dam failure (i.e. a high hazard dam in an urban area).	MEMA, DCR Office of Dam Safety	2 years	Current state & federal database of dams; Office of Dam Safety; FEMA grants	To reduce the risk of dam failures in high impact areas.	Developing updated data will enhance state, regional and local mitigation planning efforts and help reduce potential loss of life, property and other natural resources.
	(B) Update the inventory of the locations, conditions and ownership of all the high hazard dams in the state.	MEMA, DCR Office of Dam Safety	2 years	Office of Dam Safety; FEMA grants or other additional funding required.	To reduce the risk of dam failures in high impact areas.	Additional funding will help the state and communities maintain, repair, and possibly upgrade existing high hazard dams, thereby reducing potential loss of life, property and other natural resources.

PREPAREDNESS/MITIGATION PROJECTS						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
1. Fund cost-effective hazard mitigation projects through available federal grants and local cost share, especially PDM, HMGP and the (FMA) Programs.	(A) Apply for available federal hazard mitigation project grants through pre-disaster and post-disaster mitigation programs and other federal mitigation programs as the funding becomes available as well as explore state or other funding options.	MEMA, DCR	Ongoing, when RFPs are posted by FEMA or following Presidential disaster declarations	MEMA, DCR staff, FEMA grants, State Grants Administration Plan	Hazard mitigation projects are expensive and federal funding is needed by the state and communities to complete most projects.	Funding cost effective hazard mitigation projects in high risk areas, as identified in this plan as well as regional and local hazard mitigation plan, will reduce future losses.
	(B) Notify Massachusetts communities of available hazard mitigation project grant programs for local mitigation projects, including available funding through the FMA, PDM, HMGP programs and other mitigation opportunities.	MEMA, DCR	Ongoing, when RFPs are posted by FEMA or following Presidential disaster declarations	MEMA, DCR staff, FEMA grants, State Grants Administration Plan	Hazard mitigation projects are expensive and federal funding is needed by the state and communities to complete most projects.	Funding cost effective hazard mitigation projects in high risk areas, as identified in this plan as well as regional and local hazard mitigation plan, will reduce future losses.
	(C) Work with state agencies which own state facilities believed to be at high or medium flood risk (as identified in Section 4) to further evaluate the flood risk and to identify and implement appropriate mitigation strategies.	MEMA, DCR, DCAM, Interagency Committee	3 – 5 years	MEMA, DCR staff; individual agency capital funding; FEMA planning and project grant funding	Individual analyses will provide a better assessment of the flood risks as well as identify specific flood mitigation measures for implementation by state agencies.	By further identifying specific flood risks and mitigation measures for individual structures and facilities, the state can make recommendations for funding appropriate projects that will reduce or eliminate the risk to flooding.
	(D) Work with state agencies which own state facilities believed to be at medium risk for Overland Tidal Surge (as identified in Section 4) to further evaluate the risk from tidal surge and to identify and implement appropriate mitigation strategies.	MEMA, DCR, CZM, DCAM, Interagency Committee	3-5 years	MEMA, DCR, CZM staff; individual agency capital funding; FEMA planning and project grant funding	Individual analyses will provide a better assessment of the risks from tidal surge as well as identify specific flood mitigation measures for implementation by state agencies.	By further identifying specific risks from tidal surge and mitigation measures for individual structures and facilities, the state can make recommendations for funding appropriate projects that will reduce or eliminate the risk to flooding.

PREPAREDNESS/MITIGATION PROJECTS (CONTINUED)						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
	(E) Support cost-benefit analysis training of regional planning agency and community staff to assist in the FEMA grant application process.	MEMA, DCR	Ongoing as training is made available.	MEMA, DCR, FEMA staff	Training of local and regional staff to conduct effective cost benefit analysis will insure the future submission of eligible hazard mitigation projects.	Providing such training builds local capacity to develop successful federal grant applications for cost effective hazard mitigation projects.
	(F) Work with state agencies to fully identify all potential hazards to facilities before major repairs, or the construction of new facilities, in order to minimize future impacts from natural hazards, particularly flooding, storm damage and erosion.	State Interagency Committee, MEMA, DCR	Within 2 years	MEMA, DCR staff, Interagency Committee, especially DEP & CZM	Recognizing exposure to natural hazards prior to construction of all new state facilities and major renovations to such facilities will result in appropriate hazard mitigation measures being included in the master planning and design process.	Inclusion of hazard mitigation measures during the planning of facilities will save future repair and disaster assistance costs.
	(G) Develop a methodology for collecting and assessing the natural hazard risks, especially flooding, erosion and storm damage, for all current and future state owned facilities and properties.	State Interagency Committee, MEMA, DCR, DCAM	3 years	MEMA, DCR staff, Interagency Committee, especially DEP & CZM	Collecting such data will assist in identifying high risk facilities and properties, and incorporating hazard mitigation measures into the planning processes.	Improving the data on high risk facilities will assist in implementing hazard mitigation measures for specific facilities and properties.
2. Monitor, evaluate, and disseminate information on the effectiveness completed hazard mitigation projects, especially after disaster events.	(A) Prepare hazard mitigation best practices and case studies on a regular basis.	MEMA, DCR, FEMA	Ongoing following future disasters	MEMA, DCR and FEMA Public Information staff.	By sharing information on completed hazard mitigation projects that prevent loss and damages, demonstrate the effectiveness of the hazard mitigation program and help to motivate other communities to undertake similar hazard mitigation projects in the future.	Mitigation project "success stories" help to publicize the communities and effective projects, thereby raising awareness of effective hazard mitigation measures. (The state and FEMA jointly produced materials on successful hazard mitigation projects following floods in March 2001 and April 2004.)

PREPAREDNESS/MITIGATION PROJECTS (CONTINUED)						
Strategy	***Action***	***Responsible Agency/ Agencies***	***Projected Timeline***	***Resources***	***Rationale for Action***	***How Action Contributes to Mitigation Strategy***
	(B) Implement a standard information sharing procedure on disaster damage data collected by FEMA, PDA, Community Relations and Infrastructure Inspectors to use in identifying potential hazard mitigation projects.	MEMA, DCR, FEMA	Ongoing, following future disasters	MEMA, DCR and FEMA Infrastructure (Public Assistance) staff	In-the-field inspectors can provide useful information on opportunities for hazard mitigation projects.	Timely, coordinated data can better identify areas that warrant mitigation actions and eliminate duplication of efforts by programs.

5.5 Funding Resources

The availability of federal funding sources depends upon Congress' ongoing budget appropriations process. In 2003, the federal government established two comprehensive websites that track available funding from all the federal agencies at www.fedgrants.gov or www.grants.gov. In addition, it may also be helpful to check current federal appropriations from Congress through the Federal Registers at thomas.loc.gov.

A current listing of federal funding sources as of 2004 may also be found in Appendix M: List of Federal Programs Funding Hazard Mitigation Projects.

A Summary of Federal Funding Sources

The following is a summary of programs are the primary source for federal funding of hazard mitigation projects and activities in Massachusetts. A more detailed list of these and other federal agencies that fund hazard mitigation projects and plans may be found in Appendix M.

Program	*Type of Assistance*	*Availability*	*Managing Agency*	*Funding Source*
National Flood Insurance Program (NFIP)	Pre-Disaster Insurance	Any time (pre and post disaster)	DCR Flood Hazard Management Program	Property Owner, Federal Emergency Management Agency
Community Rating System (CRS) (Part of the NFIP)	Flood Insurance Discounts	Any time (pre and post disaster)	DCR Flood Hazard Management Program	Property Owner
Flood Mitigation Assistance (FMA) Program	Cost share grants for pre-disaster planning and projects	Annual pre-disaster grant program	DCR & MEMA	75% FEMA/25% local government or organization
Hazard Mitigation Grant Program (HMGP)	Post-disaster Cost-Share Grants	Post disaster program	DCR & MEMA	75% FEMA/25% local government or organization
Pre-Disaster Mitigation Program	National, competitive grant program for multiple hazard mitigation projects and "all hazards" planning	Annual, pre-disaster mitigation program	DCR & MEMA	75% FEMA/25% local government or organization
Small Business Administration (SBA) Mitigation Loans	Pre- and Post-disaster loans to qualified businesses	Ongoing	MEMA	Small Business Administration
Infrastructure Support Program (formerly Public Assistance)	Post-disaster aid to state and local governments	Post Disaster	MEMA	FEMA

The Federal Emergency Management Agency (FEMA), which is now part of the Department of Homeland Security, administers the National Flood Insurance Program, the Community Rating System, the Flood Mitigation Assistance Program (FMA), the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation Program (PDM). All of these programs are administered in coordination with DCR and MEMA.

Immediately following Presidential declarations, FEMA's Response and Recovery Division works closely with state agencies, especially MEMA, in assisting in the short-term and long-term recovery effort. FEMA assists disaster affected communities through emergency funding programs, such as Infrastructure Support and Human Services. In coordination with its Mitigation Division, Response and Recovery distributes information on hazard mitigation methods and acquisition/relocation initiatives as well as coordinating HMGP grants for mitigation projects to protect eligible damaged public and private nonprofit facilities through the Infrastructure Support Program. In addition to these programs, FEMA also provides disaster recovery and hazard mitigation training at its Emergency Management Institute in Emmitsburg, Maryland. For the latest information on this and other mitigation funding programs, go to FEMA's website at www.fema.gov.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)
Type of Assistance: Pre-Disaster Insurance
***State Managing Agency*:** Massachusetts Dept. of Conservation and Recreation (DCR)
Funding Source: Property Owner, Federal Emergency Management Agency

The National Flood Insurance Program (NFIP), established by Congress in 1968, provides flood insurance to property owners in participating communities. This program is a direct agreement between the federal government and the local community that flood insurance will be made available to residents in exchange for community compliance with minimum floodplain management requirements. Since homeowners' insurance does not cover flooding, a community's participation in the NFIP is vital to protecting property in the floodplain as well as ensuring that federally backed mortgages and loans can be used to finance property within the floodplain.

Pursuant to the Flood Disaster Protection Act of 1973, many forms of federal financial assistance, including disaster assistance and federally regulated loans, related to structures located in the 100-year floodplain are contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies, but also from federally insured institutions. In order for property owners to be eligible for purchasing flood insurance through the federal government, their respective community must be participating in good standing in the NFIP.

Communities participating in the NFIP must:

- Adopt the Flood Insurance Rate Maps as an overlay regulatory district or through another enforceable measure
- Require that all new construction or substantial improvement to existing structures in the flood hazard area will compliant with the construction standards of the NFIP
- Require additional design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones

In Massachusetts, the majority of the NFIP construction standards are contained in the Massachusetts State Building Code (Section 3107) which is implemented at the local level by municipal building inspectors. Most Massachusetts communities (332 out of 351, or 94%) are participants in good standing in the NFIP.

COMMUNITY RATING SYSTEM (CRS)
(PART OF THE NATIONAL FLOOD INSURANCE PROGRAM)
Type of Assistance: Flood Insurance Discounts
***Managing Agency*:** DCR Flood Hazard Management Program
Funding Source: NFIP, FEMA

A voluntary initiative of the NFIP, the Community Rating System (CRS) encourages communities to undertake activities that exceed the minimum NFIP floodplain management standards. Communities participating in CRS can reduce flood insurance premiums paid by policy holders in that community by performing such activities as: maintaining records of floodplain development, publicizing the flood hazard, improving flood data, and maintaining open space. Communities can gain additional credit under CRS by developing a flood mitigation plan.

FLOOD MITIGATION ASSISTANCE PROGRAM (FMA)
Type of Assistance: Cost share grants for planning and projects
Managing Agency: DCR & MEMA
Funding Source: NFIP/Federal Emergency Management Agency

Authorized by the National Flood Insurance Reform Act of 1994, the Flood Mitigation Assistance (FMA) program makes cost-shared grants available for flood mitigation planning and projects, such as property acquisition, relocation of residents living in floodplains, and retrofitting of existing structures within a floodplain. Flood hazard mitigation plans, approved by the state and FEMA, are a pre-requisite for receiving FMA project grants. FEMA provides a federal share of up to 75% of the cost of the plan or project while communities and/or homeowners contribute a minimum of 25%. For a complete list of FMA funded flood mitigation plans and projects, see Appendix L.

HAZARD MITIGATION GRANT PROGRAM (HMGP)
Type of Assistance: Post-disaster Cost-Share Grants
Managing Agency: DCR & MEMA
Funding Source: FEMA

Established pursuant to Section 404 of the Stafford Disaster Relief and Emergency Relief Act (PL 100-707), this program provides matching grants (75% Federal, 25% non-Federal) for FEMA-approved hazard mitigation projects following a Presidentially declared disaster. These grants are available to state, local and tribal governments as well as some non-profit organizations. The grants are specifically directed toward reducing future hazard losses, and can be used for projects protecting property and other resources against the damaging effects of floods, hurricanes, earthquakes, high winds, and other natural hazards. HMGP in Massachusetts encourages non-structural hazard mitigation measures, such as:

- The acquisition of damaged structures and deeding the land to a community for open space or recreational use
- Relocating damaged or flood prone structures out of a high hazard area

- Retrofitting properties to resist the damaging effects of natural hazards. Retrofitting can include wet- or dry-flood proofing, elevation of the structure above flood level, elevation of utilities, or proper anchoring of the structure.

Proposals for funding are submitted for review by Massachusetts' Interagency Hazard Mitigation Committee which makes recommendations to the Commissioner of DCR and the Director of MEMA for their review and approval. The committee uses a list of criteria contained in the Hazard Mitigation Grant Program Administrative Plan (see Appendix K). Review and final approval of state recommendations is made by FEMA's Region I office. For current and past HMGP funded projects, see Appendix L.

PRE-DISASTER MITIGATION PROGRAM
Type of Assistance: National, competitive grant program for multiple hazard mitigation projects and "all hazards" mitigation plans
Managing Agency: MEMA & DCR
Funding Source: FEMA/Dept. of Homeland Security/Office of Domestic Preparedness

The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. Chapter 68, as amended by §102 of the Disaster Mitigation Act of 2000. Funding for the program is provided through the National Pre-Disaster Mitigation Fund to assist states, local governments and Indian Tribal governments in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program. All applicants must be participating and in good standing in the National Flood Insurance Program (NFIP) if they have been identified through the NFIP as having a Special Flood Hazard Area.

44 CFR Part 201, Hazard Mitigation Planning, establishes criteria for State and local hazard mitigation planning authorized by §322 of the Stafford Act, as amended by §104 of the DMA. After November 1, 2004, local governments and Indian Tribal governments applying for PDM funds through the States will have to have an approved local mitigation plan prior to the receipt of local mitigation project grants. States will also be required to have an approved Standard State mitigation plan in order to receive PDM funds for State or local mitigation projects after November 1, 2004. Therefore, the development of State and local multi-hazard mitigation plans is key to maintaining eligibility for future PDM funding.[xliii] For current information on available Pre-Disaster Mitigation Program, refer to FEMA's website at http://www.fema.gov/fima/pdm.shtm.

SMALL BUSINESS ADMINISTRATION (SBA) MITIGATION LOANS
Type of Assistance: Pre-disaster mitigation loans to qualified business
Managing Agency: MEMA
Funding Source: Small Business Administration

The SBA's Pre-Disaster Mitigation Loan Program was developed in support of FEMA's Pre-Disaster Mitigation program. SBA's pilot loan program was authorized at a level of $15 million for each of five fiscal years from 2000 to 2004 to provide loans to small businesses for the purpose of implementing mitigation measures to protect their property from disaster-related damage. Eligible small businesses may borrow up to $50,000 each fiscal year at a fixed interest rate of four percent per annum or less for mitigation measures approved in the loan request.

Businesses proposing mitigation measures to protect against flooding must be located in a Special Flood Hazard Area (SFHA).

To apply for a pre-disaster mitigation loan, a business must submit a complete Pre-Disaster Mitigation Small Business Loan Application within the 30-day application period announced by the SBA. SBA will publish a Notice of Availability of Pre-disaster Mitigation Loans in the Federal Register announcing the availability of pre-disaster mitigation loans each fiscal year. The Federal Register notice will designate a 30-day application period with a specific opening date and filing deadline, as well as the locations for obtaining and filing loan applications. In addition, SBA will coordinate with FEMA, and will issue press releases to the local media to inform potential loan applicants where to obtain loan applications.

A business' proposed mitigation measure as described in the application must conform to the priorities and goals of the mitigation plan for the community in which the business is located. For more information on this program, The Small Business Administration (SBA) published a Final Rule on their Pre-Disaster Mitigation Loan Program in the Federal Register on October 7, 2002. The Federal Register may be viewed online.

INFRASTRUCTURE SUPPORT PROGRAM
***Type of Assistance*:** Post-disaster Cost-Share Grants
State Managing Agency: MEMA
***Funding Source*:** FEMA

The Federal Emergency Management Agency's Infrastructure Support Program is triggered for counties declared major disaster areas by the President. Communities and public agencies in designated counties are eligible for partial reimbursement (75%) of expenses for emergency services and removal of debris, and partial funding (75%) for repair and replacement of public facilities which were damaged by the declared disaster. Massachusetts funds an additional 12.5% of these projects. Cost-effective hazard mitigation measures to protect eligible facilities from future damage can be included as part of the disaster assistance. Eligible applicants for Infrastructure Assistance include:

- State government agencies/departments
- Local governments (county, city, town, village, district, etc.)
- Certain private non-profit organizations

For the latest updates on this FEMA program, refer to the FEMA website at www.fema.gov.

VOLUNTEER FIRE ASSISTANCE (VFA) GRANTS
***Type of Assistance*:** Pre-disaster Grants
State Managing Agency: DCR Fire Bureau Office
***Funding Source*:** USDA Forest Service

Volunteer Fire Assistance (VFA) is a Federal grant program that provides funds for fire equipment, training, and initial fire department organization to fire departments serving small communities under 10,000 in population. Congressionally appropriated VFA funds are provided to the State forestry agencies through the USDA Forest Service. The State forestry agencies pass this money on to needful fire departments within their states. A fire department may buy equipment, pay for training or training materials, or cover the cost of department incorporation, as long as the funds are matched. VFA funds are granted on a 50/50 matching basis. In other words, the department must match the dollars, dollar for dollar, in money, time, or equipment. Most grants are $5,000 or less. Actual amounts depend on the VFA funding allocated to the particular State, which in turn depends on Congressional action

ASSISTANCE TO FIREFIGHTERS GRANTS PROGRAM - FIRE PREVENTION & SAFETY GRANTS
***Type of Assistance*:** Pre-disaster Grants
Managing Agencies: Local or community organizations, including fire departments, state, regional and national organizations
***Funding Source*:** Dept. of Homeland Security/Office of Domestic Preparedness

This grant program awards grants to national, regional, State, local, or community organizations (including fire departments) that are recognized for their experience and expertise in fire prevention or safety programs and activities. Private non-profit and public organizations are eligible to apply for funding for these grants. Fire departments that have received or applied for training, equipment, vehicles, etc. under the FY 2004 Assistance to Firefighter Grant Program are eligible to apply for the fire prevention grants in this application period. However, funding to any organization is limited to a $750,000 Federal share per program year.

Hazard Mitigation Funding In Massachusetts

The following section gives an overview of pre-disaster and post-disaster federal hazard mitigation funding in Massachusetts since 1991.

Hazard Mitigation Grant Program - There have been six Presidential Declared Disasters since 1991 which have allowed for funding of post-disaster hazard mitigation funding under the Hazard Mitigation Grant Program. These disasters include Hurricane Bob in August 1991, northeasters in October 1991 and December 1992, floods in October 1996 and June 1998, and a snowstorm and floods in March 2001. The HMGP grant amount for a seventh Presidential disaster declaration in April 2004 is to be announced.

Under the Hazard Mitigation Grant Program (HMGP), over 100 hazard mitigation projects have been funded in Massachusetts since 1991. The current cost-sharing for the HMGP is 75% Federal/25% non-Federal; however, for earlier disasters (prior to 1993) the cost-sharing was 50% Federal/50% non-Federal.

Disaster	# Projects	HMGP Federal Funds	Federal Share
1991 Hurricane Bob (DR 914)	16	$653,291	50%
1991 No-Name Storm (DR 920)	10	$733,715	50%
1992 Dec. Northeaster (DR 975)	7	$477,947	50%
1996 October Storm & Floods (DR 1142)	36	$12,262,500	75%
1998 June Storm & Floods (DR 1224)	19	$1,652,209	75%
2001 March Snowstorm & Floods (DR 1364)	*16*	*$1,562,356*	75%
2004 April Floods (DR 1512)	*TBA*	*TBA*	75%
Total	*104*	*$17,342,078*	

(Source: MEMA Hazard Mitigation Grants Coordinator, Interagency Team Meeting Presentation, June 2004))

In 1997 and 1998, additional funding for hazard mitigation projects became available under the federal Housing and Urban Development's (HUD) Community Development Block Grant Disaster Recovery Initiative (DRI). These funds in 1997 were 100% federal funds and did not require a local or state match. In 1997, HUD notified the Commonwealth that $4,297,911 in DRI funds was available for communities that suffered damage following the 1996 floods. The Commonwealth developed a set of allocation criteria based on need to distribute the funding among eligible communities.

In 1998, DRI funding of $1.5 million became available for flood mitigation work in the Muddy River Watershed in the Town of Brookline and the City of Boston. These funds, however, were 75% federal with a 25% match from both the Town of Brookline and the City of Boston.

1997 & 98 Housing & Urban Development Disaster Recovery Initiative (DRI) (100% Federal Funds)

Disaster	# Projects	DRI Funds	Designated Areas
1996 October Storm & Floods (DR 1142)	11	$4,297,911 (100% Federal)	Essex, Middlesex, Norfolk, Suffolk, Plymouth Counties
1998 June Storm & Floods (DR 1224)	2	$1,500,000 (75% Federal)	Town of Brookline, City of Boston
Total	*13*	*$5,297,911*	

(Source: MEMA Disaster Recovery Division Hazard Mitigation Database, April 2004)

For more detailed descriptions and information on specific hazard mitigation projects and more photos, see Appendix L.

1997 – 2003 MA Flood Mitigation Assistance (FMA) Funding of Local Flood Mitigation Projects & Plans

Year	FMA Project Funding (75%)	FMA Plan Funding (75%)	Funded Projects	Funded Plans
1997	$268, 400	$27,800	1	3
1998	$255,060	$10,800	2	1
1999	$378,010	$49,000	2	4
2000	$315,360	$30,700	2	4
2001	$303,120	$35,935	5	4
2002	$263,790	$29,800	2	1
2003	$210,870	$33,600	1	1
2004	TBA	TBA		
Total	***$1,994,610***	***$217,635***	***15***	***18***

(Source: MEMA Disaster Recovery Division Hazard Mitigation Database, April 2004)

2002 – 2004 PDM Program Funding for Mitigation Plans

Year	Regional Planning Agency	Federal Funds
2002	Cape Cod Commission (CCC)	$40,000
2002	Franklin Regional Council of Governments (FRCOG)	$59,250
2002	Metropolitan Area Planning Council (MAPC)	$153,750
2002	Southeastern Regional Economic and Planning District (SRPEDD)	$100,000
2003	Old Colony Planning Council (OCPC)	$79,725
2003	Northern Middlesex Planning Council (NMCOG)	$25,000
2003	Berkshire Regional Planning Commission (BRPC)	$58,915
2003	Franklin Regional Council of Governments (FRCOG)	$59,898
	Total	***$576,538***

State Funding Sources

Matching FEMA Assistance – Following Presidential disaster declarations, the state contributes half of the 25% non-federal share for federal Infrastructure Support funds. Since 1991, the state has contributed **$12,528,157** to match FEMA's funding following declared Presidential disasters (see Major Disaster Declarations in Massachusetts, pages 105 - 107).

Special Appropriations Following State Disasters – Although there is no separate state disaster relief fund in Massachusetts, the state legislature enacts special appropriations for those communities sustaining damages following a natural disaster that are not large enough for a Presidential, disaster declaration. Since 1991, Massachusetts has issued 10 state disaster declarations, providing **$7,177,251** in funding to aid affected communities.

State Revolving Fund – This statewide loan program through the Executive Office of Environmental Affairs assists communities in funding local stormwater management projects which help to minimize and/or eliminate flooding in poor drainage areas.

State Land Acquisition & Conservation Program – Through the Massachusetts Executive Office of Environmental Affairs, this annual program purchases private property for open space, wetland protection and floodplain preservation purposes. For instance, in 1998, the state set an ambitious goal of protecting 200,000 acres of open space in the Commonwealth by 2010. In August 2001, less than three years later, the state announced that the Commonwealth and its land protection partners had reached the halfway mark in achieving that goal - 100,000 acres. Updated information may be found on the website of the Executive Office of Environmental Affairs Open Space Protection program at http://www.mass.gov/envir/openspace/default.htm.

Major Flood Control Projects - The state provides half of the non-federal share on the costs of major flood control projects developed in conjunction with the U.S. Army Corps of Engineers. This program is managed by DCR.

Natural Resource Conservation Service (NRCS) PL566 Flood Control Dams – The state funds operation and maintenance of the 25 PL566 flood control dams located on state property.

Flood Hazard Management Program Staff Funding – The state provides the 25% non-federal share for FEMA's funding under the Community Assistance Program - State Support Services Element (CAP-SSSE). CAP-SSSE funding, and the state match, support the Flood Hazard Management Program (FHMP) within the Department of Conservation and Recreation. The FHMP works with FEMA to coordinate the National Flood Insurance Program throughout Massachusetts, providing technical assistance to participating communities, professionals, and individuals.

Hazard Mitigation Project Support – The state provides the 25% non-federal share toward the administration of the federally-funded hazard mitigation grant programs. See the overview of current hazard mitigation project funding in Appendix L.

MA Mitigation Success Story

Massachusetts' Largest Acquisition Project in Flood Prone Lawrence Neighborhood

The weather in March 2001 dealt Lawrence a severe blow. The city of 70,000 people was the first municipality to have National Guard troops in to help after 30 inches of snow fell. Subsequent flooding caused damage for just fewer than 200 residents who registered for disaster assistance programs. It could have been worse. Lawrence has a lot of water running through it and a history of repetitive losses because of flooding. Historically, one of the hardest hit areas has been the Arlington District neighborhood in the Spicket River floodplain.

"We didn't have to evacuate this time, but we lost heat and hot water in seven units," said Jonathan Steeves, manager of administration and finance for the Office of Planning and Development for the City of Lawrence.

The three-family homes on Holly Street had already been bought and were slated for demolition to create a two-acre city park. When the project is completed, 34 families in all will have moved out of harm's way.

Funding for the $2.2 million project comes from the Federal Emergency Management Agency Hazard Mitigation Grant Program ($1,022,333), the U.S. Department of Housing and Urban Development ($1,000,000), the Massachusetts Department of Housing and Community Development ($200,000) and the Economic Development Administration ($10,000).

The October 1996 floods affected approximately 200 structures, while roads and bridges in the area were impassable due to floodwaters, endangering residents and rescue personnel. A 100-year event in 1987 caused even more widespread and severe damage in the area, requiring mass evacuations in flooded areas of the city.

"Old sewer maps drawn in the 1880s reveal that the Spicket originally looped down through the Holly Street and Daisy Street area. At the turn of the century, the river was channeled and straightened out. Perhaps nature cannot be denied," wrote Mayor Mary Claire Kennedy in a letter supporting the city's application for the acquisition project.

6. Regional & Local Planning Coordination

6.1 Local Capability Assessment

As mentioned earlier in Section 3, Government Structure in Massachusetts, local municipalities, rather than counties, have the primary authority over land use and development in Massachusetts. Local governments for Massachusetts' 351 communities have a vital role in natural hazards mitigation especially in floodplain management activities. The municipal Building Departments, Conservation Commissions, and Boards of Health all have the legal responsibility to be the frontline implementers of local floodplain ordinances or by-laws, the National Flood Insurance Program (NFIP) construction standards incorporated in the Massachusetts State Building Code, and floodplain guidelines incorporated in the Wetlands Protection Act, and Title 5 of the State Environmental Code (wastewater disposal).

The following is an overview of the departments found within the majority of Massachusetts municipalities. In many smaller communities, a few paid part-time staff wearing several "hats" and/or volunteers fulfill some of the following responsibilities that affect hazard mitigation planning:

Function	*Description*	*Effect on Loss Reduction*	*Opportunities*
Building department and local building inspectors	The Building Inspector implements and enforces the Massachusetts State Building Code (specifically Section 3107, "Flood Resistant Construction"), which incorporates the NFIP construction standards. The building inspector also enforces locally adopted by-laws, especially to prevent floods. The state building code includes sections on wind, snow, structural loads and seismic retrofitting.	Insures that the NFIP standards and other mitigation standards are uniformly applied statewide. For instance, the building inspector is responsible for administering municipal zoning ordinances, including those addressing floodplains.	Building inspectors may often find potential problems and/or violations of the State Building Code. There may be more opportunities for the state to provide additional training to local building inspectors concerning new hazard mitigation measures.
Public works department and/or town engineer	The Department of Public Works and/or the Water and Sewer Departments, which are primarily responsible for municipal drainage and stormwater management systems, take the lead in insuring the communities' compliance with the EPA's Phase II Storm Water Regulations	Because storm water flooding is one of the major flood hazards in Massachusetts, ongoing maintenance and upgrading of local stormwater systems by local public works departments is crucial to reducing flood risks.	Public works staffs are integral in implementing local hazard mitigation plans, especially in identifying and implementing local hazard mitigation projects.

Conservation Commissions	The Conservation Commission has primary responsibility for implementing the MA Rivers Protection Act of 1996 (MGL Ch. 258, 310 CMR 10.58), MA Wetlands Protection Act (MGL Ch. 131, Section 40), (310 CMR 10.00). The Conservation Commission reviews, approves or denies applications for any project in the regulatory 100-year floodplain, in the floodplain of a small water body not covered by a FEMA study, within 100 feet of any wetland or 200 feet of any river or stream.	These regulations contain performance standards which address flood control and storm damage prevention. For instance, the Wetlands Protection Act restricts development in wetlands and within a 100 foot buffer zone. Since most wetlands are within the 100 year floodplain, this adds an extra layer of protection to promote flood loss protection.	All new development with potential impacts on any type of river, stream, ponds or wetlands must be reviewed by local Conservation Commission. These commissions play an important role in enforcing regulations that minimize flood impacts.
Planning boards, planning department, and/or town planner	This board has the general planning authority under the MGL Ch. 41 Zoning Act, and implements local subdivision regulations. The planning board's responsibilities include recommending land use regulations to protect the public health, safety, and welfare. The Planning Board is the primary vehicle at the local level that ensures that new development incorporates federal and state storm water management "best management practices." The Planning Board is responsible for maintaining floodplain bylaws and ordinances to address current floodplain issues and updating them to ensure compliance with state and federal regulations.	Often coordinates the hazard mitigation planning process and the implementation of hazard mitigation plans. Provides professional expertise in plan development, bylaw drafting and grant application preparation.	Planning boards can often bring in regional planning perspectives as well as information concerning new developments.
Board of Health	This local board implements the State Environmental Code, Title 5, and 310 CMR 15: Minimum Requirements for the Subsurface Disposal of Sanitary Sewage. The community may adopt local board of health requirements that are more restrictive than the state requirements.	Title 5 protects public health and mitigates losses due to adverse effects of improper sewage treatment in high hazard areas. Also, this board becomes involved in issues related to water quality, and infectious diseases following disasters.	By involvement of this board, additional public health issues may be included within the mitigation planning process.

Board of Selectmen or City Council	Massachusetts cities are governed by elected Mayors and City Councils, but towns are typically governed by Boards of Selectmen. A Board of Selectmen is usually elected for a one- or two-year term. In most towns, town meetings of all registered voters meet at least annually. [Some towns have adopted representative town meetings.] This tradition from Colonial times approves town budgets and all land use and zoning ordinances and regulations.	These bodies are the chief elected officials of each municipality and provide leadership and approval for hazard mitigation grant applications, plans and potential projects.	More education needed concerning the benefits of hazard mitigation planning and projects.
Emergency Management	Each Massachusetts community has an emergency manager who is primarily responsible for local response and recovery as well as mutual aid for natural and man-made hazards.	Emergency managers play a primary role in developing local comprehensive emergency management (CEM) plans, required by MA state law, as well as other plans required by MEMA and FEMA.	More education needed concerning the benefits of hazard mitigation planning and projects.

Developing Local Mitigation Plans

Most communities in Massachusetts do not have the existing staff capability to develop hazard mitigation plans without technical assistance or funding. For instance, in the seven years since mitigation planning funding has been available through the Flood Mitigation Assistance Program (FMA), only one Massachusetts community, Brockton, has developed a FEMA-approved flood mitigation plan without federal funding.

In recognition of this reality, the Massachusetts State Mitigation Planning Strategy was developed to fund regional planning agencies (RPAs) through the Pre-Disaster Mitigation (PDM) program in order to assist municipalities in developing local hazard mitigation plans. The RPAs have professional planners on staff with extensive knowledge of the communities within their regions. A more detailed description of the Massachusetts State Mitigation Planning Strategy is found in Section X.

In addition, Massachusetts has taken advantage of post-disaster hazard mitigation planning funds under the Hazard Mitigation Grant Program (HMGP) to support local hazard mitigation planning. In 2001, following the March 2001 Presidential disaster declaration for winter storm flooding, Massachusetts made 5% of its HMGP funding for the development of multi-hazard mitigation plans by communities. Three communities applied for and received funding for such plans – Framingham, Marblehead, and Melrose. Drafts of these plans may be found in Appendix X and are pending approval by FEMA Region I. Once approved, data from these plans will be incorporated into the state plan.

Local Hazard Mitigation Measures

As the local hazard mitigation plans are completed as annexes to the aforementioned regional hazard mitigation plans, these local mitigation measures and projects will be incorporated into the State Hazard Mitigation Plan. These local measures and projects, like the regional hazard mitigation measures and

projects, will be reviewed and analyzed by the State Team of DCR and MEMA staff as well as the State Interagency Committee. Again, dependent upon future funding, the Commonwealth will provide the participating communities with technical assistance as needed for the implementation of cost-effective hazard mitigation measures.

This section of this plan will be updated with input from participating communities and the regional planning agencies, funded through PDM planning grants complete the multi-jurisdictional and local "all hazard" mitigation plans.

6.2 Local Funding and Technical Assistance

Since 1997, Massachusetts has been providing local funding of mitigation plans, primarily flood mitigation plans, as well as technical assistance. The State Mitigation Team, composed of MEMA and DCR staff, started closely working with Massachusetts communities in 1997 on local flood mitigation plans in accordance with the Flood Mitigation Assistance (FMA) program. This program provides annual funding, through the NFIP, for communities to develop local flood mitigation plans. In 1997, the state also hired a full-time staff person, a mitigation planner, to work on the State Mitigation Plan as well as to provide technical assistance, with other State Mitigation Team members, to communities working on FMA plans.

Massachusetts is one of only a few states that have a position solely dedicated to hazard mitigation planning. This planning position, State Hazard Mitigation Planning Coordinator, has been expanded to provide technical planning assistance to RPAs and communities that are developing all hazards plans as well as updating the State Hazard Mitigation Plan to meet new requirements under DMA 2000.

This technical planning assistance has involved meeting with local officials and the local planning teams on an "as needed" basis to provide overviews of the hazard mitigation planning process and the mitigation plan's requirements, as well as descriptions of potential hazard mitigation measures. As of September 1, 2004, 15 communities have developed flood mitigation plans. The following chart provides an overview of these plans, the grants and the mitigation projects that resulted due to these plans:

Local Flood Mitigation Plans & Resulting Mitigation Project in Massachusetts 1997 - 2004

Community	Year of FMA Planning Grant	Grant Amount (75% Federal)	Year Completed and Approved	Projects completed or underway	FMA Project Grant Amount (75% Federal)
Braintree	1998	$2,730	1999	Drainage/stormwater management project completed in 2000; Drainage improvements to mitigate flooding of properties on Rex Dr. and West St.	$28,913 in 2000; $162,414 in 2003
Brockton	none	None	1998	Acquisition of one rep. loss property on Belmont Ave & will be maintained as open space. Completed in 2001.	$81,145.85
North Andover	2001	$9,750	2004	None at this time.	
North Reading	1999	$11,000	2001	None at this time (although North Reading has received HMGP funding for mitigation projects).	
Northampton	2001	$12,000	2004	None at this time.	
Peabody	1998	$10,800	2001	Hydraulic study of downtown flood problems and development of priority projects to mitigate flooding. Completed in 2003.	$43,500
Plymouth	1998	$14,864.33	2000	Coastal flood protection, seawall improvement with cap, completed in 2002	$293,685
Revere	1999	$15,000	2001	Upgrade Broad Sound Ave. drainage system to protect rep. loss properties from flooding	$67,000
Sandwich	2000	$7,600	2002	None at this time.	
Salisbury	1999	$6,107	2001	None at this time	
Scituate	1999	$12,930	2001	Elevation and retrofit of rep. loss properties completed in 2000 (Scituate had a CRS plan at that time); 2002; and 2004	$249,000 in 2000; $198,715.08 in 2002; $202,995 in 2004
Tewksbury	1997	$10,000	1999	Elevation of 2 rep. loss properties above base flood elevation, completed in 2003	$56,967/15
Westwood	2000	$7,600	2002	None at this time.	
Weymouth	2000	$7,600	2001	Study of flood problems and determination of priority projects to mitigate flooding, completed in 2003.	$26,625
Wilbraham	2001	$6,685	2003	None at this time.	

Source: 2004 MEMA Hazard Mitigation Project Database

Following a Presidentially declared disaster in March 2001, Massachusetts was able to fund 3 communities – Framingham, Marblehead and Melrose- to develop local multi-hazard mitigation plans, using available planning funds from the HMGP. These three plans will be completed by the end of 2004 (see below).

Individual Community Multi-Hazard Mitigation Plans

Individual Community	Grant year & type	Amount (75% Federal)	Completion Date	Projects
Framingham	2001 HMGP	$15,000	Dec. 2004	TBA
Marblehead	2001 HMGP	$15,000	Dec. 2004	TBA
Melrose	2001 HMGP	$15,000	Dec. 2004	TBA

As part of the Statewide Hazard Mitigation Strategy, the state began a partnership with regional planning agencies to develop multi-jurisdictional plans with local annexes. The state has been able to fund seven of the 13 regional planning agencies with Pre-Disaster Mitigation (PDM) Planning grants, and the state intends to pursue future PDM funding to assist the remaining regional planning agencies. A chart listing all of these RPAs and the communities within their jurisdictions may be found in Section 3.2.

6.3 Local Plan Integration

Massachusetts will integrate new data from all local, multi-hazard plans into the State Hazard Mitigation Plan. The process and timeline for the integration of these plans is tied directly to the State Hazard Mitigation Planning Strategy (see Section 3.1.2.) which involves partnerships with all the Massachusetts Regional Planning Agencies (RPAs). With funding from the Pre-Disaster Mitigation (PDM) program, the RPAs will be completing multi-jurisdictional, all hazards plans, with the main focus on natural hazards.

Massachusetts intends to review each of these multi-jurisdictional plans, based on FEMA's *Local Hazard Mitigation Plan Review Crosswalk*, and provide comments back to RPAs within 4 weeks of the RPAs final plan submittal to the state. The state, in turn, will then incorporate new data into the State Hazard Mitigation Plan within 6 months of completion of the regional plans. The Massachusetts State Hazard Mitigation Planning Coordinator, who is part of the State Mitigation Team and the State Interagency Hazard Mitigation Committee, will manage this review and analysis process.

The timeline for the completion and integration of the plans for 2002 and 2003 PDM funded RPAs is as follows:

Regional Planning Agency	***Plan Due Date***	***State Plan Analysis & Inclusion***
Berkshire Regional Planning Commission (BRPC)	**July 2005**	**July 2006**
Cape Cod Commission (CCC)	**Dec. 2004**	**Dec. 2005**
Franklin Regional Council of Governments(FRCOG)	**Dec. 2004**	**Dec. 2005**
Metropolitan Area Planning Council (MAPC)	**Dec. 2004**	**Dec. 2005**
Northern Middlesex Council of Governments (NMCOG)	**July 2005**	**July 2006**
Old Colony Planning Council (OCPC)	**July 2005**	**July 2006**
Southeastern Regional Planning and Economic Development District (SRPEDD)	**Dec. 2004**	**Dec. 2005**

The schedule for the remaining 6 RPAs in Massachusetts that are in the process of applying for PDM funding will be dependent on the final plan due date determined by the 2004 and 2005 PDM funding cycle as well as the available planning funds from the FMA program and HMGP. In addition, the 3 communities (Framingham, Marblehead and Melrose) with all hazards mitigation plans funded through 2001 HMGP funding, will be reviewed and integrated into this state plan no later than June 2005.

6.4 Prioritizing Local Assistance

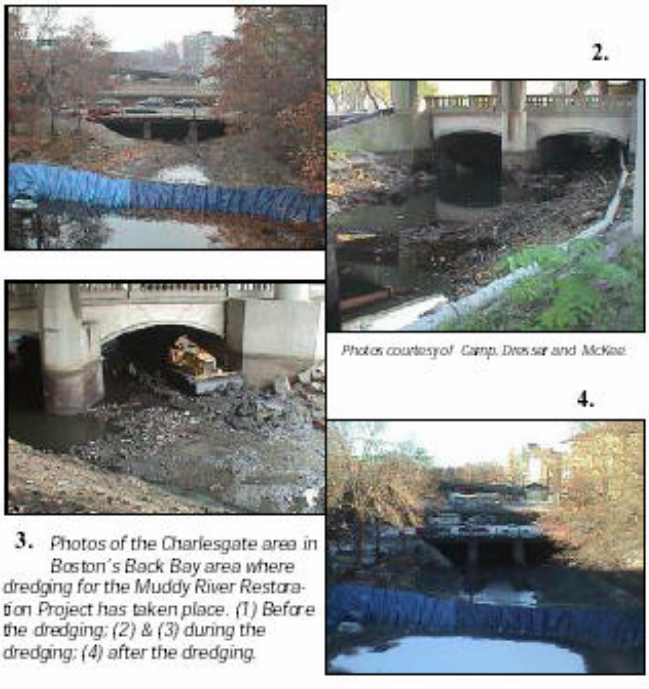
Massachusetts will use its Mitigation Hazard Mitigation Grants Administration plan to review and prioritize local hazard mitigation assistance. See Section 5.3 for a description of the prioritization criteria and Appendix J for the Massachusetts Hazard Mitigation Grants Administration Plan.

MA Mitigation Success Story

Muddy River Comes Clean with Restoration Project

The Muddy River has flooded three times since the fall of 1996, causing damage to residents, businesses and institutions in Boston and Brookline along the Emerald Necklace. These events brought together a diverse group of stakeholders to prevent future flooding, including universities, museums, businesses, and residents working together with the City of Boston, Town of Brookline and the State of Massachusetts to restore the Muddy River. This river restoration and flood prevention project was also a step in implementing the Emerald Necklace Master Plan's landscape and historic resource treatments to undo the effects of erosion, storm damage, and neglect over the years.

Completed by Frederick Law Olmsted in 1895, the 6 mile long Emerald Necklace was the first linear park in this country. It's comprised of a series of parklands and vehicular parkways linked by the wetlands of the Muddy River. The five major parts of the system include the Back Bay Fens, Muddy River Improvement, Jamaica Park, Arnold Arboretum and Franklin Park, and their connecting parkways (Fenway, Riverway, Jamaicaway and Arborway).



3. Photos of the Charlesgate area in Boston's Back Bay area where dredging for the Muddy River Restoration Project has taken place. (1) Before the dredging; (2) & (3) during the dredging; (4) after the dredging.

The Muddy River Restoration Project is Phase I of the 1999 Emerald Necklace Master Plan. The first phase of the project included coordination of federal, state and local agencies funding for engineering, design and project management tasks. This phase ended with the dredging and physical improvements to the Charlesgate section of the project. The project partners included the Federal Emergency Management Agency (FEMA), the Department of Housing and Urban Development (HUD), the MA Emergency Management Agency (MEMA), MA Department of Conservation and Recreation (DCR), MA Department of Housing and Community Development (DHCD), City of Boston, Town of Brookline, Boston Water and Sewer Commission and many residents.

The dredging resulted in an improved, higher capacity channel from the Charles River to the Richardson Bridge. This completed the first stage of improved flood control, aquatic habitat and water quality for the Muddy River project through the removal of built-up and contaminated sediments. Over 3,000 cubic yards of material was dredged and disposed of off site. 1500 feet of the channel was dredged between Storrow Drive and Boylston Street in Boston. The many pieces of debris removed from the river filled numerous hauling containers and 600 feet of conduit under Storrow Drive was inspected and cleaned out by divers. The banks of the river were enhanced and stabilized through the planting of over 800 shrubs.

(Source: MA Mitigation News, January 2004)

7. Plan Maintenance Process

7.1 Monitoring, Evaluating and Updating this Plan

The Massachusetts State Hazard Mitigation Plan is a living document which will be reviewed, updated and adopted by state officials and submitted to FEMA for approval every three years. Per the Massachusetts State Hazard Mitigation Strategy outlined in this plan, the plan will be revised more frequently as multi-jurisdictional and local plans are completed and if conditions under which the plan was developed change, such as a major disaster or a new or revised state policy.

This section describes the process through which this plan will be updated. Federal hazard mitigation planning regulations (44 CFR 201.4) require the state plan to be reviewed, revised and submitted for approval to the Regional Director of FEMA every three years. The regulations require a plan maintenance process that includes an established method and schedule for monitoring, evaluating and updating the plan; a system for monitoring implementation of mitigation measures and project closeouts; and a system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategy.

Plan Maintenance Process

The State Hazard Mitigation Team of the Department of Conservation and Recreation (DCR) and the Massachusetts Emergency Management Agency (MEMA) is responsible for developing and maintaining the Massachusetts State Hazard Mitigation Plan. The team's State Hazard Mitigation Planning Coordinator is the individual responsible for overseeing this work.

Additional Participants in the plan maintenance process include the following:

- The State Interagency Hazard Mitigation Interagency Committee (see Section 3.3)
- Representatives from the regional planning agencies (RPAs)
- Representatives of local jurisdictions whose hazard mitigation plans were used in the development of the multi-jurisdictional plans, or who developed a "stand alone" local plan.

The state plan review will take place in three ways:

- Annually for progress made on mitigation actions and projects identified in the Mitigation Strategy of the state plan in Section 5
- After each major disaster in Massachusetts declared by the president, to look for areas where the state plan should be refocused due to the impact of the disaster.
- Every three years, before submission to FEMA for approval per federal regulations.

7.2 Monitoring Progress of Mitigation Activities

Annual Progress Review

The purpose of the annual review is to gauge the progress of mitigation activities as well as to evaluate any changed conditions that may affect hazard mitigation planning and implementation in Massachusetts. The state plan will be reviewed annually to reflect significant policy changes that took place during the preceding year and to report on the progress made on funded hazard mitigation projects statewide. Based on FEMA approving the Massachusetts State Hazard Mitigation Plan in November 2004, this annual review will take place at the end of the calendar year.

Review on the progress implementing the actions and measures identified in the state plan will occur at this time. Once a year, the State Hazard Mitigation Interagency Committee and other participants (see previous page) will:

- Review, revise and update the state plan's Risk and Vulnerability Assessment as necessary to incorporate any changes and/or updates. This will include a review and update of hazard profiles and data on vulnerable state facilities.
- Examine progress on mitigation actins and projects in the State Mitigation Strategy, especially progress on the multi-jurisdictional and local plans.
- Identify any implementation problems (financial, technical, political and legal).
- Recommend how to solve such problems and to increase involvement of state agencies, local jurisdictions and the private sector in hazard mitigation planning.
- Review, revise and update the State Capability Assessment and the Mitigation Strategy in Section 5 to reflect major changes in policies, priorities, programs and funding.

Post Disaster Review

After each Presidential disaster declaration and in coordination with FEMA, the State Interagency Hazard Mitigation Committee will assist in documenting the effects of the disaster and convene a meeting of all the state planning participants in Section 7.1. The purpose of this meeting is to share observations and data related to the disaster and to review specific hazard mitigation needs of the disaster affected area. This will allow for the development of hazard mitigation recommendations to FEMA during the disaster operation as well as to update the State Hazard Mitigation Strategy as needed.

This post-disaster review may replace an annual review in any year a major disaster occurs, depending on the disaster event's severity and time of year.

Three-Year Plan Review and Revision

The State Hazard Mitigation Team will facilitate the review and revision of the Massachusetts State Hazard Mitigation Plan every three years. The review and revision will begin approximately 9 to 12 months before FEMA approval is required. Review and revision will involve the State Interagency Hazard Mitigation Committee and the other planning participants, especially those RPAs which have completed multi-jurisdictional plans. This process will incorporate all the revisions made during the annual plan review, especially new data obtained from the completed multi-jurisdictional plans. As these multi-jurisdictional plans are completed per the timeline chart in Section X, the local data obtained, especially new information on hazard identification and risk assessment, will be incorporated into the three year update.

The State Interagency Hazard Mitigation Committee and other planning partners will:

- Examine and revise the Hazard Identification and Risk Assessment section, in order to remain current and accurate. New data from the completed multi-jurisdictional plans will be vital to updating these sections of the state plan.

- Examine the progress on and determine the effectiveness of the mitigation strategies and actions outlined in the State Mitigation Strategy and in the multi-jurisdictional plans and local annexes, and determine how the performance of such recommendations will influence the State Mitigation Strategy. It is anticipated that local governments and regional planning agencies, pending available funding, will review and revise their plans and annexes using the processes that they have identified and described in the in plans and annexes.

- Examine the effectiveness of funded, local mitigation projects (see following section on monitoring projects) and determine how the performance of those projects should influence the State Mitigation Strategy.

- Examine the overall implementation of the state plan, identify problems (financial, technical, political and legal), and develop recommendations to overcome them.

- Recommend ways to increase participation by state agencies and local jurisdictions in the hazard mitigation planning process.

- Recommend any necessary revisions to the Risk Assessment and to the State Mitigation Strategy to reflect changes in federal and state policies, priorities, programs and funding, and incorporating new information following major disaster events.

- Following review and revision of the state plan, participants will analyze the plan maintenance process and the project monitoring process, and make appropriate changes to improve these processes.

Monitoring Plans & Projects Implementation and Closeouts

In addition to the monitoring activities of the State Interagency Hazard Mitigation Committee, the State Hazard Mitigation Team, consisting of full-time staff members with DCR and MEMA, will monitor the progress of hazard mitigation plans and projects through the following activities, which will be shared with the Interagency Committee and will be incorporated into the annual update of the state plan:

Mitigation Projects Monitoring Activity	***Who***	***Responsibilities***	***Timeline***
Site Visits	MEMA Grants Manager, DCR Project Manager, members of the State Interagency Committee	To evaluate the potential project; to monitor progress; and to ensure that the contracted work has been completed.	Before a grant is awarded; during construction; and upon completion of a project.
Questionnaires	MEMA/DCR State Planning Coordinator	Send out a questionnaire to participating regional planning agencies and communities to determine progress on the mitigation planning process as well as gathering information to evaluate what is working and what isn't working.	Annually, beginning in the spring of 2005 following the completion of several multi-jurisdictional plans.
Quarterly Reports	MEMA Grants Manager	Each community or organization receiving mitigation grants must file quarterly reports with the state. Required by the state	Quarterly.
Mitigation Project Database	MEMA Grants Manager, DCR Project Manager, State Hazard Mitigation Officer	Update the tracking database with current financial information and site visit information, using data from the quarterly reports.	Ongoing as needed.
State Grants Administration Plan	MEMA Grants Manager, State Planning Coordinator, State Hazard Mitigation Officer	Review current mitigation grant and project guidelines and make updates when appropriate, especially as federal regulations are updated.	Per federal regulations, must be updated after every disaster declaration; otherwise every 3 years with the rest of the State Mitigation Plan.

Comments & More Information

Any comments, questions, corrections or suggestion concerning any part of this plan should be addressed to:

Richard Zingarelli
State Hazard Mitigation Officer
Department of Conservation & Recreation
Flood Hazard Management Program
251 Causeway St., 8th Floor
Boston, MA 02114
617-626-1406

Endnotes

[i] "Reducing Disaster Vulnerability Through Science and Technology," National Science and Technology Council, Committee on the Environment and Natural Resources, An Interim Report of the Subcommittee on Disaster Reduction, July 2003, p. 5.

[ii] Federal Emergency Management Agency, Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA, First Edition, 1997, xxi/Introduction.

[iii] Floods: Congressional Natural Hazards Caucus Fact Sheet, July 2001 www.agiweb.org/workgroup

[iv] FEMA National Flood Insurance Program website, http://www.fema.gov/hazards/floods Dec. 2003

[v] Friends of the River publication, website http://www.friendsoftheriver.org/Publications/BeyondFloodControl/no5.html Feb. 2004

[vi] Federal Emergency Management Agency, Flood Insurance Study, Town of Plymouth, Massachusetts, prepared by PRC Harris, Inc., Long Wharf, Boston, MA, June 1983.

[vii] Massachusetts Office of Coastal Zone Management, "Massachusetts Shifting Shorelines: New Data on Shoreline Change," April 2002

[viii] James F. O'Connell, Massachusetts' Experience through Three Presidentially Declared Coastal Storm Disasters, Hazard Mitigation and New Initiatives, published in the proceedings of the 19th Annual Conference of the Association of State Floodplain Managers, Portland, ME, May 1995, page 2.

[ix] Ibid, "Massachusetts Shifting Shorelines: New Data on Shoreline Change, " April 2002

[x] National Hurricane Center's Website, *Glossary of National Hurricane Center Terms, www.nhc.noaa.gov, Feb. 2004)*

[xi] Center for Educational Technologies, NOAA's Classroom of the Future Program, COTF Website, http://zone.cps.k12.il.us/Projects/Grades_9-12/Severe_Weather/Activity_1/Hurricane_Formation/hurricane_formation.html, Feb. 2004

[xii] The Tornado Project Website, http://www.tornadoproject.com, Feb. 2004

[xiii] National Severe Storms Laboratory, NOAA, website, http://www.nssl.noaa.gov/NWSTornado/ . Feb.2004

[xiv] U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory website, http://www.crrel.usace.army.mil/ierd/icejam/icejam.htm#intro

[xv] National Drought Mitigation website, http://enso.unl.edu/ndmc/center/ndmc.htm , Oct. 2003

[xvi] Congressional Natural Hazards Caucus Fact Sheet: Drought, pp.1-2, http://www.agiweb.org/workgroup/drought0802.pdf

[xvii] USGS, National Water Summary 1988 – 89 – Floods and Droughts: State Summaries, S. William Wandle, Jr., p. 331

[xviii] DCR Bureau of Fire Control, 2002 – 2003 Annual Report to the DCR Commissioner, pp.10 – 15.

[xix] Commonwealth of Massachusetts, 409 Hazard Mitigation Plan Annex, Wildfires June 1996, Department of Environmental Management, Division of Resource Conservation and Division of Forests and Parks, page 3.

Endnotes

[xx] The Pacific Disaster Center website, www.pdc.org, Jan. 2004)

[xxi] Boston College and the Massachusetts Emergency Management Agency Earthquakes in New England Newsletter, Weston Observatory, Boston College, 1991.

[xxii] New England States Earthquake Consortium, New England Earthquake Fact Sheets, Portsmouth, NH, 1991.

[xxiii] Earthquakes, by Kaye M. Shedlock & Louis C. Pakiser, website, http://pubs.usgs.gov/gip/earthq1 10/23/97

[xxiv] U.S. Geological Survey, National Landslide Hazards Program, website, http://landslides.usgs.gov/html_files/landslides/program.html, Feb. 2004

[xxv] Ibid, the Dewberry Company, February 2004, p. 20.

[xxvi] Ibid, Feb. 2004

[xxvii] Environmental Protection Agency's Global Warming site, http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html, February 2004.

[xxviii] The Office of Massachusetts Attorney General Tom Reilly, *Fact Sheet: Massachusetts Global Warming Impacts, as Reported by the US EPA,* 2003, http://www.ago.state.ma.us/sp.cfm?pageid=1234

[xxix] "Emergencies, Accidents and Spills," Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, http://www.epa.gov/oswer/emergencies.htm

[xxx] Reducing Disaster Vulnerability Through Science and Technology – An Interim Report of the Subcommittee on Disaster Reduction, July 2003, National Science and Technology Council, Committee on the Environment and Natural Resources, p. 10.

[xxxi] Commonwealth of Massachusetts, Annex to 409 Hazard Mitigation Plan, Pursuant to Disaster No. FEMA-975-DR-Ma, December 11 – 13, 1992 Northeast Storm, Dept. of Environmental Management and the Massachusetts Emergency Management Agency, pages 4 & 5.

[xxxii] Federal Emergency Management Agency, Interagency Hazard Mitigation Team Report, FEMA-DR-1224-MA, June 1998 Floods, page 6.

[xxxiii] Massachusetts Hazard Mitigation Strategy, Spring 2001 Floods, DR 1364, pages 2 & 3.

[xxxiv] National Flood Insurance Program, Insured Losses in Massachusetts, Feb. 1999 (see Appendix F).

[xxxv] Riverways Program News, Dec. 2003, http://www.state.ma.us/dfwele/RIVER/newsnotesnov03.htm

[xxxvi] *Massachusetts Drought Management Plan, 2000, Historical Background page 5.*

[xxxvii] Commonwealth of Massachusetts, 409 Hazard Mitigation Plan Annex, Wildfires June 1996, Department of Environmental Management, Division of Resource Conservation and Division of Forests and Parks, page 3.

[xxxviii] Commonwealth of Massachusetts 409 Hazard Mitigation Plan Annex – Wildfires, Update Pursuant to Federal Emergency Management Agency Fire Suppression Assistance Agreement, June 1996, p. 5.

[xxxix] U.S.Census Data, 2000.

Endnotes

[xl] Ibid, p.5

[xli] Project Summary Report: Pre-Disaster Mitigation Program Grant, State Plan Update of Vulnerability and Risk Assessment, The Dewberry Company, February 2004, pp. 18 – 19

[xlii] Ibid, the Dewberry Company, February 2004, p. 4.

[xliii] Federal Emergency Management Agency (FEMA) website, Pre-Disaster Mitigation Program, April 2004 http://www.fema.gov/fima/pdm.shtm